THURSDAY, MAY 25, 1893.

REASON *versus* INSTINCT.

The Intelligence of Animals. By Charles William Purnell, Barrister-at-Law. (Christchurch and Dunedin, N.Z.: Whitcombe and Tombs, Limited, 1893.)

THIS little work has been written, the author states, in order to awaken public interest in the daily lives of the numerous animals which surround us, and to enforce the view that they are not mere lumps of animated clay, but creatures quickened by the fire of intelligence, and mentally as well as physically our brethren. The facts and arguments of modern writers on the subject have been condensed, and the results presented in a way calculated to interest the average reader, but always from the somewhat peculiar standpoint of the author. In his own words:—"The object of this work is, first, to prove that, among animals instinct, as distinguished from intelligence, is non-existent, that, in fact, it is a mere name; and, secondly, that the intelligence of the higher animals is essentially the same as our own."

After giving the definition of instinct from several writers, he proceeds to discuss the "Origin of Instincts," and he attributes it to hereditary habit, apparently unaware that the hereditary transmission of habits is either doubted or actually denied by a large number of naturalists. And he does not seem quite clear himself as to the meaning attached to the term, and to the necessity of excluding in any particular case in which it is alleged to exist, the possible influence of imitation, of physical or mental idiosyncrasies which are admittedly hereditary, and of natural or artificial selection. He considers handwriting to be sometimes hereditary, but does not apparently see that both imitation and inherited muscular or nervous peculiarities are almost sure to be present; while in the case of trained dogs and horses whose acquired habits are supposed to be hereditary, he clearly perceives that selection comes in, since he says:—"We know precisely how these habits have been acquired. The dogs and horses have been taught them by slow degrees; the animals displaying most aptitude for their acquisition have been carefully selected as breeders, until, finally, the habit has grown into the animal's mental constitution, and is perpetuated from parent to offspring." Further on, he tells us that when the beaver builds a lodge or constructs a dam, it does so by virtue of the inherited experiences of its forefathers. Of this there is no evidence whatever, while we are told that there is evidence of increased skill with age; so that instruction by, and imitation of, the older animals, with progressive improvement through experience, will account for all the facts.

A considerable portion of the work is occupied by facts and arguments directed against the doctrine that the actions of animals emanate from blind instinct, a doctrine which Mr. Purnell seems to think is almost universally held. When speaking of animals exhibiting joy, grief, love, hatred, pride, shame, revenge, or jealousy, he adds that we cannot conceive of an automaton being thus moved. And, after describing the dances of gnats and other insects, and the amusements of ants, he again declares that he cannot believe that these are "mindless beings no more responsible for their actions than the piston of a steam engine." Similar remarks are repeated again and again, as if the doctrine of the automatism of animals, instead of a philosopher's paradox, was the common belief of the educated world.

The author fully adopts the view that animals possess an æsthetic sense, admiring beauty of form and colour for its own sake; and he appears to be quite unaware that all the facts he adduces are explicable on the theory that the varied ornaments which we admire as being beautiful in themselves, may be to animals mere signs of the presence of desirable objects. Throughout his chapter on this subject he repeatedly states as facts, that animals *do* love beauty; that what delights our eyes delights their eyes also; that they admire the beauty of their fellow's brilliant colours; and as an indication that this is so, he urges that the colours of all animals form "harmonious combinations." The colours may be gaudy or odd, but they "harmonise well together," and "a true and perfect harmony does actually prevail in the colours of animals." This is often asserted, but how can it be proved? Do the glaring colours of the blue and yellow macaw form a harmonious combination? Or those of many of the barbets or chatterers? The colours, contemplated individually, are beautiful, owing to their purity and the delicacy of the glossy surface on which they are exhibited, often presenting the lustre of silk or satin, or the soft texture of velvet, while the rounded contours and delicate gradations of tint are also pleasing. Bu to assert that the combinations of colours are always, or even usually harmonious, in the sense in which we use the term as applied to combinations in a lady's dress or in the decorations of a room, seems to me to be completely opposed to the facts.

Notwithstanding these slight drawbacks, the work is full of interest. Almost every aspect of the subject is touched upon, and the writer often displays much originality in his discussions. We find very interesting chapters on the amusements of animals, on their individuality of character, on the education of their young, and on their language; and if he had confined his statement as to reason *versus* instinct, to the case of the higher animals, we might have been inclined to acknowledge that his view is the correct one. He does not, however, attempt to show how the theory of reason will apply to the acts of the larvæ of many insects, which seek special stations and construct special habitations for the pupæ, or of the perfect insects which lay up food for their young with the most admirable foresight and precautions. For these cases he falls back on hereditary habit; but it is difficult to see how this differs from the instinct which at the outset he denies the existence of.

Among the most original portions of the book is the chapter "On the Aspect which Man presents to the Lower Animals," and that on "The Animal View of the World." These are not so purely speculative as would appear at first sight, and some very good reasons are advanced for the conclusions arrived at. Mr. Purnell holds very strong views as to the rights of animals. He

maintains that we are not justified in destroying them without adequate reasons. "The struggle for existence may force us to kill them for food or for our own self preservation; but the mere sportsman, and still less, he who destroys animals simply in order to display his skill in shooting, can show no moral sanction for his acts." And after a strong protest against cruelty to animals, he adds:—"Fortunately for us, the memory of the unutterable wrongs which dumb animals have sustained at man's hands cannot have been transmitted by them from generation to generation, or assuredly the entire Animal Kingdom would rise up in fierce rebellion against the common oppressor!"

On the whole, the book is very pleasingly and clearly written; it is divided into a number of short chapters each treating some well-defined aspect of the question; it contains examples of the best and most instructive facts illustrative of animal intelligence, and it is pervaded by a feeling of sympathy for the whole of animated nature. It is a pity that it is not issued in a more attractive form, the paper covers being hardly suited for such a book; but it is nevertheless well adapted as an introduction to the study of the subject, and will be especially interesting to those who think highly of the intelligence as opposed to the mere instincts of animals, and who are not afraid to recognise that even in their mental faculties and emotions the lower animals have much in common with ourselves.

ALFRED R. WALLACE.

OUR BOOK SHELF.

The Principles of Agriculture. By G. Fletcher. (Derby: The Central Educational Company, Ld.)

THIS little book is essentially a note-book of lectures given by the author, at the instance of the Technical Education Committee of the Derbyshire County Council, to schoolmasters and others intending to become teachers of agriculture. The syllabus covers the ground usually gone over in such a course, the arrangement of subjects being somewhat similar to that adopted by Fream in his well-known "Elements." The book contains, in a small space, a good deal of information, and, at the same time, indicates points with which the student should make himself acquainted, but which could not be given in detail in a work of this kind. It seems to be carefully written, and, on the whole, very free from errors; it will, no doubt, be a useful guide both to teachers and students of agriculture.

Au Bord de la Mer: Géologie, Faune, et Flore des Côtes de France. Par le Dr. E. L. Trouessart. (Paris: J. B. Baillière et Fils, 1893.)

IT often happens that people who go to the seaside for a holiday would be glad, if they could, to learn something about the scientific meaning of the objects by which they are surrounded. They have neither time nor inclination for the study of elaborate works, and as a rule there is not much to be gained by the perusal of local guide-books. Persons of this class in France will find exactly what they want in the present volume. The author gives first a sketch of the geology of the French coasts from Dunkirk to Biarritz, then deals with such marine plants as are likely to interest the reader, and finally presents an account of marine animals. The style is clear and unpretending, and the text is illustrated with no fewer than 149 figures.

LETTERS TO THE EDITOR.

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Mr. H. O. Forbes's Discoveries in the Chatham Islands.

IN a recent letter in NATURE (vol. xlviii. p. 27), under the above heading, Mr. Wallace has done me the honour to make some observations on the conclusions I have arrived at on other discoveries I have made in the Chatham Islands, and on the evidence adduced in my paper read before the Royal Geographical Society on March 12 last, *i.e.*, that an Antarctic continent—which I may name Antipodea—is necessary to explain the distribution of life in the southern hemisphere. Mr. Wallace says, "It is this tremendous hypothesis which appears to me to be not only quite unnecessary to explain the facts, but also to be inadequate to explain them. If one thing more than another is clear, it is that these comparatively small flightless birds were developed, as such, in or near to the islands where they are now found, since they could not possibly have arisen on any extensive land inhabited by carnivorous mammals and reptiles, and, if introduced into such a country could not long survive." If by this Mr. Wallace means that only the flightlessness of these birds, apart from their general structure as members of the genus *Aphanapteryx*, arose in or near the islands where they now are, he still leaves the, to me, greater difficulty unexplained how two so closely related species of the same genus should have arisen in regions separated by nearly one half of the circumference of the globe. For it has to be remembered that *Aphanapteryx* belongs to the *Ocydromine* group of the Rails, which is quite unknown in the northern hemisphere, and, therefore, to have reached "Lemuria" (the ancient land of which Madagascar, Mauritius, Bourbon, Rodriguez, and the Seychelles, are the fragments) the genus must have arisen independently in both regions where its species are now found, or it spread from one or the other centre, or from some common land *by flight*. Mr. Wallace has himself pointed out that to explain the presence of the flightless *Notornis* and *Ocydromus* in two groups of islands in the New Zealand region requires a land connection, for it has been hitherto considered an axiom of geographical distribution that the regions inhabited by the same genus or species have been continuous, or have been, at all events, such as to afford possibilities of migration from one to another. If *Aphanapteryx* could have spread from the Chatham Islands to Mauritius by flight, surely *Notornis* and *Ocydromus* did not require a land connection to reach from New Zealand to the nearer outlying islands, for they may equally have lost the use of their wings only after they reached their present homes.

When Mr. Wallace asserts that these birds "could not possibly have arisen on any extensive land inhabited by carnivorous mammals and reptiles," he affirms what does not really appear to me to carry with it conviction without more proof. Rails belong to a family of birds that have become of world-wide distribution, not improbably because of the habits of its members enabling them to escape destruction. They are better runners than flyers; they are water and marsh-loving birds, many of them living in reed and rush brakes, and the dense vegetation surrounding marshes, amid which pursuit is difficult or impossible. I was much struck when in the Chatham Islands by observing how the habits of the small *Ortygometra tabuensis* protected it. The upland districts of Wharekauri are covered by a very dense rush-like vegetation—the *terahina* of the natives—in which this little Rail lives. We hunted over acres and acres of country with the aid of a dog well trained to pursue and catch this species, but only after two days did we succeed in securing a specimen. We could see that the dog disturbed plenty of birds, but so rapidly could they make their way through the *terahina* that they all escaped, for they never took to flight. The *Cabalus modestus* is a nocturnal bird hiding securely in hollow trees and grass thickets all day. *Notornis* inhabited, and perhaps still inhabits, the dense scrub of the south-western portion of New Zealand, and could have there escaped the severest persecution of carnivorous animals and reptiles. But even if *Aphanapteryx* had been subjected to the incessant and successful attacks of such enemies, its extinction, whether early or late, would de-

pend on the numbers in which it was reproduced. Many species of animals, it is needless to point out, such as rats and mice, are ceaselessly persecuted by enemies, and yet survive, and from time to time spread over vast areas. The lemming, notwithstanding that thousands yearly perish by their own act, and from the attacks of enemies during their migration, has not become extinct. Nor can I see that 2000 miles is such an "enormous extent of land" for a migration to extend over, even in face of carnivorous mammals and reptiles. It is at least not so great as the distance covered during the migration of the South American tapirs from Central Europe *via* Behring's Straits to Brazil, the route supposed by Mr. Wallace to have been taken by the ancestors of these interesting animals.

Mr. Wallace asks, "What difficulty is there in the same or closely allied species of this widespread group finding their way at some remote epoch to Mauritius and the Chatham Islands, and from similar causes in both islands, losing their power of flight while retaining their general similarity of structure?" I must reply, none; and then ask in turn, from where did they find their way? which is the point under discussion. I am constrained to believe that they came from an extensive land, capable of supporting large numbers of them, which must have been continuous with (as indicated by other evidence) or approaching close to both regions, otherwise we have to believe that this strictly Notogæan group has "found its way" across half the globe, or has arisen independently in both regions from different sections of the family—an occurrence which we have no evidence to warrant our believing has ever taken place.

I am unable to speak for the present opinions of Prof. Newton or his brother; but I know of no additional evidence that has come to light that is likely to have modified their well-considered opinion of a few years ago. On the contrary, it seems to me confirmatory of their views.

I beg, however, to protest against the implication that I have invoked this "tremendous hypothesis" to account for the distribution of the *Aphanapteryx* and *Fulica* I discovered. I have given prominence no doubt to the valuable evidence their presence contributes, additional only, however, to the numerous other facts I have adduced in my paper before the Royal Geographical Society, in support of the theory that a land of extensive dimensions—not isolated islands only as Mr. Wallace agrees to—existed in the southern seas, in order to explain the distribution of plants and animals, *unknown in the northern side of the equator*, in regions so distant as South America, Australia, New Zealand, and "Lemuria." I have, in my own opinion, adduced no more cogent facts pointing in this direction than those published by the late Prof. W. K. Parker, showing plainly the common ancestry existing between the Notogæan (Gymnorhine) crows of Australia, and the Dendrocolaptine birds of South America. Their common progenitor must have occupied some *southern* land connected with both Australia and South America.

I might adduce still other weighty examples from the domain of ornithology, tending to support my opinion, which have been kindly communicated to me by Dr. Bowdler Sharpe, but I forbear now, as I understand that this will form the subject of the second lecture of the course he is now delivering on Thursday afternoons at the Royal Institution.

104, Philbeach Gardens, May 20. HENRY O. FORBES.

Phagocytes of Green Oysters.

IN your issue of May 4 you refer in a note to a suggestion made by my friend and former pupil, Dr. Paul Pelseneer that the green amœboid cells described by me as occurring on the surface of the gills of green oysters are to be interpreted as out-wandered phagocytes. It is, I think, only right to point out that Dr. Pelseneer (as he is careful to explain in the note published by him) has made no new observations on the matter, and merely professes to give an interpretation of the facts which I described in 1886 in the *Quart. Journ. Micr. Sci.* in my article on green oysters. I there described and figured large granular cells occurring in and upon the epithelium of the gill-filaments and regarding them as epithelial secretion-cells attributed to them the active part in the elimination of the blue pigment "marennin" taken in by the oyster in its food—the diatom *Navicula ostrearia*. At that time the general doctrine of "phagocytosis" had not been so fully developed as it is now seven years later. But I may say that already in 1887 one of my pupils (Mr. Blundstone) had established to my satisfaction the existence of extensive out-wandering of phagocytes through the surface epithelium of *Anodon* in various regions of the body, and that I was very soon led by the accumulating evidence of a similar kind (*e.g.* Durham's observations on star-fishes) to adopt the view that the large "secretion-cells" discovered by me both in the epithelium of the oyster's gill and freely moving on its surface, were out-wandered phagocytes. I have taught this view in my lectures, and have made some further observations (two years ago) on similar out-wandering phagocytes in other Lamellibranchs. The subject is one well worthy of minute study, phagocytosis in Mollusca being as yet an unexplored ground likely to yield results of great physiological importance. E. RAY LANKESTER.

Oxford, May 7.

The Conjoint Board's Medical Biology.

THE pertinent remarks of L. C. M. (NATURE, vol. xlviii., p. 29), and G. B. H. (vol. xlvii., p. 530), respecting the course of elementary biology prescribed by the Conjoint Board, expresses, I think, the feelings of most biologists.

Either it is desirable, or not, that previous to entering upon a course of purely medical studies the student should have a training in elementary biology. The Board have decided in the affirmative, and have prescribed a course as amusing as it is absurd. It demands a practical acquaintance with the structure of certain protozoa, *Hydra*, the leech, two or three parasitic worms, a scrappy knowledge of botany, and a few generalities. The insecta, crustacea, mollusca, and the whole of the vertebrata, are entirely omitted in the practical work. Under such circumstances it is almost ridiculous to attempt to impart any true knowledge of biology, in fact it is quite impossible to do so, for in the absence of such types as the crayfish, dogfish or cod, very many important morphological facts cannot be illustrated.

It would be interesting to learn the constitution of the committee who have drawn up this inexplicable syllabus. One really cannot for a moment suppose that they are acquainted with the scope and aim of present-day biological teaching, but from hazy memories of their student days, and an acquaintance with *Tænia*, *Ascaris*, and the leech, have drawn up the present course. The examination, I should remark, is in *perfect keeping* with the syllabus.

The important morphological facts to be gained by a dissection of the leech are probably best known to the Board.

It is sincerely to be hoped that the matter may not be allowed to rest here, but that some steps will be taken to impress upon the Board the utter absurdity of their present syllabus and mode and standard of examination, and the need for a recognized course in both zoology and botany.

WALTER E. COLLINGE.

Mason College, Birmingham, May 15.

Vectors *versus* Quaternions.

AS in recent numbers of NATURE my views on analysis have been quoted, and not very correctly, I ask for space to state them more explicitly. I see truth in the quaternion analysis and in the vector analysis; but I believe that neither the one nor the other, nor the two combined, contain the whole truth. The vector is an important idea, and the quaternion is an important idea, but there are in physical science many other important ideas which call for a more direct notation. To avoid any narrow hypothesis I denominated my first paper "Principles of the Algebra of Physics"; but in the notice which NATURE honoured it with it was printed as "Principles of the Algebra of Vectors." The title I gave it indicates briefly my position. I have been looking at analysis from the point of view of the physicist, and one of my guiding ideas has been that the fundamental rules of analysis, instead of being assumed as so many arbitrary rules of operation, should be grounded on the fundamental laws of physics.

What is the greatest want of the physicist of the present day? It is a generalised analysis which shall not contradict the Cartesian analysis, but be a logical generalisation of it, which shall include and harmonise such methods as the Double Algebra of Argand, Cauchy, and De Morgan (an excellent presentation of which has recently been published by Mr. Hayward), the method of Determinants, the Matrices of Cayley, the

Quaternions of Hamilton and Tait, the *Ausdehnungslehre* of Grassmann, the vector analysis of Gibbs and Heaviside. It is this problem of how to harmonise, unify, generalise, and extend that I have been studying. Analysts and physicists dislike Mr. McAulay's idea of an independent plant; they prefer to cultivate the old tree venerable with the growth of ages.

After studying impartially all the writers at my command I came to the conclusion that the analysis of vectors is complementary to the analysis of versors, and that the fundamentel rules for the former are:—

$$i^2 = + \qquad j^2 = + \qquad k^2 = + \qquad (1)$$
$$ij = -ji \qquad jk = -kj \qquad ik = -ki \qquad (2)$$
$$ij = k \qquad jk = i \qquad ki = j \qquad (3);$$

whereas for the latter they are:—

$$\overset{\shortparallel}{i}{}^2\overset{\shortparallel}{i}{}^2 = - \qquad \overset{\shortparallel}{i}{}^2\overset{\shortparallel}{j}{}^2 = - \qquad \overset{\shortparallel}{k}{}^2\overset{\shortparallel}{k}{}^2 = - \qquad (4)$$
$$\overset{\shortparallel}{i}{}^2\overset{\shortparallel}{j}{}^2 = -\overset{\shortparallel}{j}{}^2\overset{\shortparallel}{i}{}^2 \quad \overset{\shortparallel}{k}{}^2\overset{\shortparallel}{j}{}^2 = -\overset{\shortparallel}{j}{}^2\overset{\shortparallel}{k}{}^2 \quad \overset{\shortparallel}{i}{}^2\overset{\shortparallel}{k}{}^2 = -\overset{\shortparallel}{k}{}^2\overset{\shortparallel}{i}{}^2 \quad (5)$$
$$\overset{\shortparallel}{i}{}^2\overset{\shortparallel}{j}{}^2 = -\overset{\shortparallel}{k}{}^2 \qquad \overset{\shortparallel}{j}{}^2\overset{\shortparallel}{k}{}^2 = -\overset{\shortparallel}{i}{}^2 \qquad \overset{\shortparallel}{k}{}^2\overset{\shortparallel}{i}{}^2 = -\overset{\shortparallel}{j}{}^2 \qquad (6)$$

It follows that in the manipulation of the products of vectors, the distributive rule applies but not the associative; while in the products of versors both apply. These fundamental rules for vectors are based on physical considerations, the principal one of which is that the square of a vector is essentially positive, whereas, according to quaternionists, it is essentially negative. My view agrees with that principle of analysis which considers the cosine in the first and fourth quadrants to be positive; to make it negative produces confusion and error. These principles harmonise with those of Gibbs and Heaviside; and in the memoir quoted I have carried them out to their logical development. It is this development which Prof. Knott characterises as "a pseudo-quaternionic system of vector algebra, which is non-associative in its products." I see no worthy aim in being canny about the matter; my sole aim was to develop the system so that its truth or falsity might the more readily appear. At the end of his article Prof. Knott admits that the *assumption* that the square of a unit vector is positive unity leads to an algebra which is essentially different from the algebra of quaternions. As regards the fundamental principle being an assumption, I refer him to that same chapter of "Kelland and Tait" which he quotes, where he will find, italics and all:—"We retain what Sir Wm. Hamilton terms the *associative laws of multiplication*: the law which assumes that it is indifferent in what way operations are grouped, provided the order be not changed; the law which makes it indifferent whether we consider abc to be $a \times bc$ or $ab \times c$. This law is *assumed* to be applicable to multiplication in its new aspect (for example that $ijk = ij.k$) and being assumed it limits the science to certain boundaries, and, along with other assumed laws, furnishes the key to the interpretation of results. The law is by no means a necessary law. Some new forms of the science may possibly modify it hereafter. In the meantime the assumption of the law fixes the limits of the science." Here an authoritative expounder places the quaternion algebra on precisely the same footing that Dr. Knott places the "pseudo-quaternionic;" and he even predicts that in the course of time such a complementary algebra will be developed. It is incumbent on a critic, having admitted the logical development, to show that the assumptions are absurd, or correspond to nothing in physical science; instead of which he informs us that he is appalled by the complexity, but nevertheless he feels sure that it contains nothing new. As regards newness I invite his attention to pr. 93 of the "Principles," where I have investigated the rules for the several partial products of any number of vectors in space of not more than four dimensions (and they may be easily extended to space of higher dimensions). These consist of certain rules of reduction which are to be taken along with the rule of signs of determinants, thus embracing determinants and Grassmann's combinatory products in the general theory of products of vectors. He will also find there some reasons for believing that the triad of rules No. 3 are very different in nature from the other two triads, Nos. 1 and 2. It is possible to get along without No. 3.

That vectors should be treated vectorially, and versors versorially, and rotors rotorially, is neither nonsense nor a truism. It is an important maxim, and of growing importance in these days. Violation of it has produced the fundamental weakness of Hamilton's analysis. In a more recent paper I have published the generalisations for space of the exponential, binomial, multinomial, and other fundamental theorems of analysis, and I show that it was from treating versors vectorially that Hamilton failed to discover them.

Prof. Knott defines a quaternion as the quotient of two vectors. Why choose the quotient; is not the product always the simpler idea? But further on vectors are identified with quadrantal quaternions, from which it follows that a quaternion is the quotient of two quadrantal quaternions. I have devoted some attention to logic; but I fail to extract any meaning out of this implicit definition.

Prof. Knott informs the reader that whereas Heaviside and myself find that $\nabla^2 u = d^2u/dx^2 + d^2u/dy^2 + d^2u/dz^2$ the real $\nabla^2 u$ is minus that quantity; but he does not explain why Prof. Tait prefers the unreal $\nabla^2 u$ in his "Treatise on Natural Philosophy." A scientific critic would, instead of using exclamation points, proceed to show that in every case $\nabla(\nabla\omega) = (\nabla\nabla)\omega$. If that can be proved, not from any fancied properties of italic letters, but from physical considerations, then I shall readily admit that ∇ behaves as a versor rather than a vector. The *onus probandi* lies on the minus men.

Austin, Texas, May 6. ALEXANDER MACFARLANE.

An Atmospheric Phenomenon in the North China Sea.

DURING a recent wintry cruise in H.M.S. *Caroline* in the North China Sea, a curious phenomenon was seen which may be of interest to your readers. The ship was on passage between Shanghai and the western entrance of the famous inland sea of Japan. On 24th February, at 10 p.m., when in latitude 32° 58′ N., longitude 126° 33′ E., which, on reference to the map, will be seen to be sixteen to seventeen miles south of Quelpart island (south of the Korean peninsula) some unusual lights were reported by the officer of the watch between the ship and Mount Auckland, a mountain 6,000 feet high. It was a windy, cold, moonlight night. My first impression was that they were either some fires on shore, apparently higher from the horizon than a ship's masthead, or some junk's "flare up" lights raised by mirage. To the naked eye they appeared sometimes as a mass; at others, spread out in an irregular line, and, being globular in form, they resembled Chinese lanterns festooned between the masts of a lofty vessel. They bore north (magnetic), and remained on that bearing until lost sight of about midnight. As the ship was passing the land to the eastward at the rate of seven knots an hour, it soon became obvious that the lights were not on the land, though observed with the mountain behind them.

On the following night, February 25th, about the same time, 10 p.m., the ship having cleared Port Hamilton, was steering east, on the parallel of 34°, when these curious lights were again observed on the same bearing, at an altitude of 3° or 4° above the horizon. It was a clear, still, moonlight night, and cold. On this occasion there was no land in sight on a north bearing when the lights were first observed, but soon afterwards a small islet was passed, which for the time eclipsed the lights. As the ship steamed on at a rate of seven knots an hour, the lights maintained a constant bearing (magnetic) of N. 2° W., as if carried by some vessel travelling in the same direction and at the same speed. The globes of fire altered in their formation as on the previous night, now in a massed group, with an outlying light away to the right, then the isolated one would disappear, and the others would take the form of a crescent or diamond, or hang festoon-fashion in a curved line. A clear reflection or glare could be seen on the horizon beneath the lights. Through a telescope the globes appeared to be of a reddish colour, and to emit a thin smoke.

I watched them for several hours, and could distinguish no perceptible alteration in their bearing or altitude, the changes occurring only in their relative formation, but each light maintained its oval, globular form.

They remained in sight from 10 p.m. until daylight (about 5.30 a.m.). When lost sight of the bearing was one or two points to the westward of north. At daylight land 1300 feet high was seen to the north and north-north-west, distant fifty miles, the mirage being extraordinary.

Thus, these lights were seen first in longitude 126° 33′ E., and last in longitude 128° 29′ E. At first the land was behind them, but during the greater part of the distance run it was forty-five or fifty miles away to the north; and the bearing of the lights for at least three-fourths of the distance did not change.

On arrival at Kobé I read in a daily paper that the "Unknown

light of Japan" had, as was customary at this season of the year when the weather is very cold, stormy, and clear, been observed by fishermen in the Shimbara Gulf and Japanese waters. The article went on to say that these lights were referred to in native school-books, and attributed to electrical phenomena. On mentioning the matter, however, to the leading Europeans in Yokohama and Tokio, they appeared to have no knowledge of the matter.

Captain Castle, of H.M.S. *Leander*, informed me that, not long ago, the officers of his ship saw lights in the same locality which they thought at first were caused by a ship on fire. The course of the vessel was altered at once with a view of rendering assistance, but finding that the lights increased their altitude as he approached, he attributed them to some volcanic disturbance, and being pressed for time, resumed his course.

The background of high land seen on the first night dispels all idea of these extraordinary lights being due to a distant volcano. The uniformity of the bearing renders the theory of their being fires on the shore most improbable. I am inclined to the belief that they were something in the nature of St. Elmo's fires. It is probable that there are travellers among the readers of your interesting journal who have seen or heard of this phenomenon, and will be able to describe its origin and the atmospheric conditions necessary for its appearance.

CHAS. J. NORCOCK.

H.M.S. *Caroline*, Hongkong, April 10.

The Greatest Rainfall in Twenty-four Hours.

IN NATURE, May 4, Mr. Clement Wragge, of Brisbane, confidently asserts that Queensland has beaten the world's record in the extraordinary amount recorded on February 3, viz., 35·7 inches. I am sorry to have to take away such an unenviable palm from Queensland, by recalling a fact well known to every Indian meteorologist that the highest record extant belongs to Chirapunji, in the Khasia hills, where on June 14, 1876, 40·8 inches were recorded in the twenty-four hours. Not only so, but on the 12th 30 inches fell, and in the four days, from the 12th to the 15th inclusive, as much as 102 inches. Of course the effects were not so disastrous in this case, as indeed such a state of things is little removed from the normal at Chira in the early part of June, but I have a very clear recollection of it as I was at Chirapunji on the 12th and 13th, and not far from it on the memorable 14th.

The conditions which have occurred in Queensland and the North Island of New Zealand during the last six months have been a remarkable example of persistent abnormals, and though the total number of rational causes may still be wanting to explain everything, one or two were evidently in operation when I was there from October to January, and I am confident that from the empirical law of persistency, coupled with a few rational inferences, a forecast of impending floods could have been made and can be made for the future, much in the same way as the general character of the monsoon can be foretold in India.

May 13. E. DOUGLAS ARCHIBALD.

A Dust-whirl or (?) Tornado.

IN NATURE (vol. xl. p. 174) you kindly allowed me to describe a dust-whirl seen to originate on a heated dust-covered highway. The phenomenon has just been repeated under much similar circumstances, only in this instance the column of dust after oscillating to and fro on the highway for about half a minute, moved rapidly away in a curvilinear path in a northerly direction, the lower end of the whirl catching up loose material in its track where it touched the ground, which it did at intervals of from ten to fifteen yards, carrying the strawy litter from a strawberry bed upwards of 50 yards in the air. It appeared to dissipate into the upper air when crossing a meadow some 300 yards from its place of origin. The characteristic "swish" of the rushing air was very marked, and the four motions common to all tornadoes (see Lieut. Finley's "Character of Six Hundred Tornadoes"), viz. whirling from right to left, progressive motion to the north, a curvilinear track, and the dipping up and down, were all distinctly traced. The question therefore, naturally arises—Can these dust-whirls be tornadoes in miniature?

Conditions at the time of the occurrence:—Date, Thursday, May 11, 1893; time, 11 a.m. Corrected barometer, 30.327 (falling slightly). Dry bulb, 66°.5; wet, 51°.8 = rel. hum. 38 per cent. Wind, south; force, 1. Some upper cirrus radiating from north-east, and drifting slowly from north-west, showing top and bottom arcs of halo at 10 a.m. Black bulb *in vacuo* 128°.2; weather very warm and dry.

Driffield, May 11. J. LOVEL.

What becomes of the Aphis in the Winter?

I HAVE spent many weeks this spring closely observing the budding trees, with the object of discovering in what condition of life the aphis spends the winter; as the result of my observations, which were made under the microscope, I believe that the aphidæ during the autumn (or as many of them as have reached the state of reproduction) attach themselves to the stem of the tree, with their young inside them, in much the same way as the female members of the closely-allied family coccidæ do. In course of time the mother-aphis becomes simply a dried skin serving as a protection to the young. When the warm days of spring come these are developed and easily make their way through the skin and crawl on to the young leaves, there to begin their work of sucking and reproduction.

T. A. SHARPE.

Soot-figures on Ceilings.

MAY I suggest a distinct, if not an alternative cause for Prof. E. B. Poulton's soot figures in NATURE, April 27th? The ceiling plaster is very porous, except where it is in contact with the joists, etc. At such points very little deposit occurs compared with the spaces where the hot air is vigorously diffusing through into the cold space above. I suggest this because I am very familiar with a large ceiling where the rafters are thus picked out in light shades. Even the laths are picked out, but less distinctly. The main bolts likewise show dark, as in Prof. Poulton's sketch, as if there were an air-space by them. There is no perceptible difference in the figures near the central chandelier from those in the corners remotest from heating causes. The bombarding pattern is often very well shown where super-heated water pipes run along a white-washed wall. The effect of every little break, even a nail in the wall, is most striking.

J. EDMUND CLARK.

A Difficulty in Weismannism Resolved.

IN my letter of the 1st inst. an omission of parentheses and quotation marks, which I omitted to note on the proof, alters the sense of the paragraph with quotations from the "Germ Plasm," pp. 434-5. It should be as follows:—"The note runs thus: 'Compare Marcus Hartog, NATURE, vol. xliv. p. 102,' (the reference omits my letter of Oct. 31, 1891). 'The deductions made by this author are logically correct but are no longer justifiable, since I myself have gained further insight into the problems concerned.'" The absence of the inverted commas disguises this recognition by Weismann of the validity of my objections, and of the consequent change in his own views.

Cork, May 15. MARCUS HARTOG.

NOTES.

THE Hon. Ralph Abercromby has given to the Royal Society of New South Wales the sum of £100, which is to be offered as prizes with the object of bringing about exhaustive studies of certain features of Australian weather. So far only one feature has been selected, and a prize of £25 is now offered for an exhaustive study of the well-known "Southerly Burster." It is understood that no essay which does not deal fully with the following points will be considered:—(1) The motions of the various strata of clouds for some hours preceding, at the time of, and following the "burster;" (2) the weather conditions which lead up to and follow the "burster," with weather charts of Australia for the day of occurrence and the following day; (3) the general conditions which modify the character of the "burster;" (4) The area of the "burster" and its track; (5) barograph traces showing the changes of pressure during the "burster;" (6) the direction and character of wind preceding it; (7) the relation of "bursters" to rainfall. The essay must not exceed 50 pages of foolscap, and must be sent in not later than March 31, 1894. It must embody studies of several "bursters," and must be chiefly the result of original research of the author, but authors

are not debarred from making use of any available information, published or otherwise, on the subject. A photograph of each "burster" described, giving a characteristic view of the cloud roll should, if possible, be sent with the essay.

DR. N. WILLS has been appointed ordinary professor of botany at the University and Director of the Botanic Gardens at Christiania.

A MOST disastrous landslip occurred on the night of May 18, at Vaerdalen, in the district of North Trondhjem. Vaerdalen is a straggling country town with about 6000 inhabitants, and is an agricultural centre. The landslip occurred in the outskirts of the town, where there are a number of houses occupied by peasants, each farming his own land. The subsidence was so sudden and severe that between thirty and forty of these farmhouses fell instantaneously in ruins, leaving scarcely a wall standing. Twenty-two of the demolished houses were of considerable size, and many people were asleep in them when the catastrophe happened. The number of victims is estimated at close upon one hundred. The loss of property is very great. According to a Reuter's telegram, from which we learn these details, the most fruitful part of the Vaerdals-Elv Valley lies under a mass of mud and slime, and it is feared that further landslips will occur.

DURING the past week the day temperatures over the British Islands have been mostly below 70° in the south and west, while in the north of Scotland several of the maximum readings have not exceeded 55°. On the 18th inst. rainy weather had become general, with thunderstorms in many places; on that morning some heavy falls were measured, Ardrossan reporting 0·75 inch, York 0·74 inch, Loughborough 1·60 inch, and Jersey 0·91 inch, while on the following days large amounts were measured in various parts of Ireland. A small depression lying off the south-east coast of England on Sunday, the 21st inst., also brought over half an inch of rain to that part of the country, while in the early part of the present week the distribution of atmospheric pressure was favourable for further falls over the country generally. The *Weekly Weather Report* of the 20th inst. showed that the excess of temperature for that week ranged from 4° in the northern districts to 6° in most parts of England, that the rainfall was rather less than the mean in the north of Scotland, and equalled, or exceeded it, in all other districts. From the beginning of the year there is a deficit in all districts, amounting to 5·3 inches in the west of Scotland. Bright sunshine was below the average amount in all districts.

A PAPER on "Wreck-raising in the River Thames" was read by Mr. C. J. More, engineer to the Thames Conservators, at the meeting of the Institution of Civil Engineers on May 16. Mr. More mentioned that during the past eleven years seventy-four steamers of 55,758 tons register, fifty-four sailing vessels of 9,128 tons, and three hundred and one barges of 11,956 tons, being a total of 76,842 tons register of shipping, had been raised by the Conservancy lighters.

THE death of the well-known engineer, Mr. E. A. Cowper, is announced. He was in his seventy-fourth year. Mr. Cowper displayed much ingenuity as an inventor, and was connected with many technical institutions, including the Institution of Civil Engineers, of the council of which he was a member, the Institution of Mechanical Engineers, of which he was president in 1880–81, and the Iron and Steel Institute.

A MAP of the smokes of Paris has been recently prepared by M. Foubert, of the Tour Saint Jacques. The idea is to note the position of the principal factory chimneys, to observe during the day the emission of smoke, then to indicate on the map, for each chimney, by means of circles of various sizes and tints, the extent of the nuisance. There are obvious defects (as M. Delahaye points out in the *Revue Industrielle*) in such a mode of representation. Thus no account is taken of smoke from the environs, which materially affects Parisian air. The black particles emitted from factory chimneys in some cases sink rapidly, but in others are long maintained in suspension. Then there is the large emission of smoke from private dwellings. M. Delahaye manifests some partiality for city smoke; he remarks on its antiseptic properties in time of epidemic, and on the screening action, whereby it prevents losses of heat by radiation.

AT the meeting of the Linnean Society of New South Wales on March 29 Prof. David contributed a note on the discovery by him of the mineral sphene *in situ* in granite at the Bathurst waterworks. In the latest edition of his work on the minerals of New South Wales, Prof. Liversidge has described a single well-formed crystal of sphene from New South Wales, but the exact locality from which it came is uncertain. In the Bathurst granite crystals of sphene are abundant, and vary in size from $\frac{1}{20}$th up to $\frac{1}{4}$ inch in longest diameter. The crystals are of a very deep brown colour, and feebly translucent. In chemical composition the mineral is a compound of silica, lime, and titanic acid.

M. VERNER has a note in the *Journal de Physique* on an explanation of the rotation of the plane of polarisation in a magnetic field based on de Reusch's experiments. From the experimental fact that a pile of birefringent plates in which the principal sections are arranged helically rotates the plane of polarisation, it follows that a birefringent body turning about a direction perpendicular to its optical axis will rotate the plane of polarisation of a ray which traverses it parallel to the axis about which it is turning. For if the body is supposed divided into a series of plates by planes perpendicular to the axis of rotation, while the light is traversing the first plate the body will have turned through an angle, and therefore the principal plane of the second plate will be inclined to the direction which the principal plane of the first plate occupied when the light passed through it. Thus if the speed of rotation is comparable with the velocity of light the plane of polarisation will be rotated. This being so, the author makes the hypothesis that, in a magnetic field, at any given moment, the magnetic stress at a point on a line of force is only exerted in a certain azimuth normal to the direction of the line, and that the plane containing the portion of the line of force, and the direction of this stress, turns about the direction of the line of force with a velocity proportional to the intensity of the magnetic field at the point. Hence, when a substance such as carbon bisulphide is placed in a magnetic-field, this magnetic stress, transversal to the lines of force, causes the body to become birefringent, with its principal plane coinciding with the direction of this stress, and if, as is supposed, this direction rotates, the principal plane will rotate, and the substance will exhibit magnetic rotatory power. The above explanation accounts for the fact that the direction of the rotation is independent of the direction in which the ray of light traverses the magnetic field.

THE extensive researches of Pellat have shown the considerable change produced in the value of the difference of potential between the layers of air covering two metals in contact by the least chemical or mechanical alteration of the surfaces. In the *Journal de Physique* for May M. Gouré de Villemontée describes his attempts to prepare metallic surfaces which shall give a constant difference. For this purpose he deposits the metal by electrolysis on plates of copper, or on small lead shot, and has studied deposits of iron, nickel, zinc, and copper made from solutions of different salts, at tempera-

tures ranging from 10° to 40° C., and with varying current densities. The method adopted to determine the difference of potential consists in forming, with the two plates which are being experimented on, a condenser having its plates joined by a wire in which an opposing electromotive force could be produced. The conclusions the author arrives at are, that the difference of potential at the point of contact of two electrolytically deposited layers of the same metal is independent of the density of the current, and of the temperature and composition of the solution used in forming the deposit. He also finds that two deposits prepared at different times are identical, and give no contact difference of potential even when as much as a month elapses between their preparation.

AN improved apparatus for exhibiting the phenomena of gaseous diffusion is described by Prof. V. Dvorák in the *Zeitschrift für Physikalischen Unterricht*. A porous pot such as is used for galvanic batteries, but in a fresh and clean condition, is well closed by a greased cork through which pass a bent glass rod and a glass tube. The tube is attached to a narrow india-rubber tube leading to a horizontal capillary glass tube ending in a small cup. The capillary tube contains a drop of alcohol which serves as an indicator. The earthenware pot is placed in an inverted position, the glass rod serving as a handle. A tray of sulphuric acid containing pieces of zinc is placed under an inverted beaker, which collects the hydrogen evolved and is then slipped over the porous pot. The gas, entering the pot by diffusion more rapidly than the air leaves it, drives the drop of alcohol quickly outward. A similar effect is produced by coal-gas, and the opposite effect by carbonic acid or ether. This may also be strikingly shown by lightly breathing into the beaker and applying it to the porous pot, when the displacement of the drop will indicates the presence of the heavier gas in the breath.

IT is a common belief in India that, if a cobra is killed, and the remains are left in a bungalow, others of the species will be attracted to the spot. A correspondent of the *Pioneer Mail* records an incident which appears to indicate, as he says, that there is some truth in this theory. About nine months ago Col. Ilderton killed a very large cobra in the compound of his bungalow at Dinapore, and had its skin stuffed and set up by a native mochee. Since then the compound has been infested with these snakes, and no less than eight full-grown cobras, measuring from 4 ft. 8 in. to 5 ft. 4 in., have been killed there; one of which was sitting up, with its hood extended, contemplating the house where the remains of its preserved friend were. It is a curious fact that every snake when found was making in the direction of the bungalow, and most of them showed fight when tackled. The last two were within a few feet of each other, when Col. Ilderton killed them with a stick, and were advancing up the carriage drive together. No cobras have been seen in other parts of the station.

MR. HOPE HUNTER, writing in the *Journal of the Royal Agricultural and Commercial Society of British Guiana* on gold in that colony, says that the explorer has no reason to penetrate further than two hundred miles inland for the discovery of new and extensive gold fields, but that, if he desired to extend research further, the debatable land between the colony and the Brazilian possessions in the south would offer a favourable field for exploration. Mr. Hunter has been made acquainted with some particulars of an expedition composed of a party of Americans to that part some years ago. They discovered abundant evidence of the country being rich in precious metals, but the hostility of the Indians, culminating in the massacre of nearly the entire party, prematurely terminated their investigations, the few survivors making their escape with much difficulty. Mr. Hunter says that this portion of the South American continent is inhabited by various Indian tribes who are believed to practise cannibalism, and that one tribe, the Pianoghottos, on the confines of British Guiana, are well known for their inveterate hostility to strangers, many instances having been recorded of their having repulsed and murdered boats' crews penetrating to their country from the Brazilian side.

SEVERAL parcels of land and fresh-water mollusks collected by Prof. José N. Rovirosa, mainly in the State of Tabasco, Mexico, were sent last summer to the Academy of Natural Sciences, Philadelphia. As some of them are of considerable interest, a list has been prepared by Mr. H. A. Pilsbry, and is printed in the latest instalment (Part III.) of the Academy's "Proceedings" for 1892. The list is illustrated with several figures brought together on a single plate.

THE bulk of fine gloves produced in Russia are made, it seems, from foal skins. So says the U.S. Consul-general at St. Petersburg in a recent report on the subject. Very little is done in Russia, he says, in the manufacture of gloves from sheep, goat, or kid skins. Much hand-labour is needed to prepare foal skins for gloves, and it is doubtful whether they could be profitably used in countries where hand labour is dear. When well dressed they are very durable, and at the same time delicate, and have a great advantage in taking well all sorts of dyes.

THE report of the United States Commissioner of Fish and Fisheries for the fiscal year ending June 30, 1889, has just been issued. Among the appendices is an elaborate and valuable report on the fisheries of the Pacific coast of the United States, by J. W. Collins. The scope of this report is limited to a consideration of such fisheries as are prosecuted in or from the region embraced between the southern extremity of California and the north-western limit of Washington. Incidentally, a somewhat extended reference has been made to certain phases of fishery in Alaska, in explanation of industries which are controlled by capitalists of San Francisco, or elsewhere, and constitute a part of the fishing interests of the region specially treated of in the report.

THE *Journal of Geology*, which is being issued from the University Press of Chicago, promises to be a periodical of much interest to geologists. Two numbers have been published, and among the contents are papers on the pre-Cambrian rocks of the British Islands, by Sir Archibald Geikie; geology as a part of a college curriculum, by H. S. Williams; an historical sketch of the Lake Superior region to Cambrian time, by C. R. van Hise; the Glacial succession in Ohio, by F. Leverett; traces of Glacial man in Ohio, by W. H. Holmes; and the volcanic rocks of the Andes, by J. P. Iddings.

MESSRS. GAUTHIER-VILLARS ET FILS have added to their "Encyclopédie Scientifique des Aide-Mémoire" a volume entitled, "Traité Pratique de Calorimétrie Chimique," by M. Berthelot, secretary of the Academy of Sciences. In the same series have been published "L'Art de Chiffrer et Déchiffrer les Dépêches Secrètes," by the Marquis de Viaris; "Unités et Étalons," by C. E. Guillaume; and "Principes de la Machine à Vapeur," by E. Widmann.

A VOLUME containing an excellent account of "The Story of the Atlantic Telegraph," by Henry M. Field, has been issued by Messrs. Gay and Bird. The "story" is one of profound interest, and the author tells it vigorously and clearly. He is a brother of the late Cyrus W. Field, and has therefore had access to many new and important sources of information. He does full justice to the part played by his brother in the great enterprise, but does not underrate the services rendered by "the science and seamanship, the capital and the undaunted courage, of England."

A SECOND edition of Mr. W. W. Rouse Ball's "Short Account of the History of Mathematics" (reviewed in NATURE, vol. xxxix. p. 265) has been issued by Messrs. Macmillan and Co. The author has revised the book and made some changes in detail, but he explains in the preface that the general character of the work—as a popular account of the leading facts in the history of mathematics—remains unaltered.

MESSRS. CASSELL AND CO. have published a fifth edition of "The Field Naturalist's Handbook," by the late Rev. J. G. Wood and the Rev. Theodore Wood.

MESSRS. ASHER AND CO., Berlin, have begun the publication of a series of reprints of remarkable writings and maps relating to meteorology and earth-magnetism. The series is handsomely printed, and edited by Prof. G. Hellmann. The first two numbers are L. Reynmann's "Wetterbüchlein von wahrer Erkenntniss des Wetters" (1510), and Pascal's "Récit de la Grande Expérience de l'Équilibre des Liqueurs" (1648).

MESSRS. C. GRIFFIN AND CO. have published the tenth annual issue of the "Year-Book of the Scientific and Learned Societies of Great Britain and Ireland." The work comprises lists of the papers read during 1892 before societies engaged in fourteen departments of research, with the names of the authors.

MESSRS. FRIEDLÄNDER & SON, Berlin, have published an inaugural dissertation, prepared with a view to the attainment of a doctor s degree at Göttingen, by Johannes Müller, embodying the results of researches on the anatomy of Compositæ. The essay is illustrated with four plates.

A CATALOGUE of the types and figured specimens in the geological department of the Manchester Museum, Owens College, by Herbert Bolton, has been issued as one of the "Museum Handbooks." In the same series appear an "Outline Classification of the Vegetable Kingdom," by F. E. Weiss, and a second edition of Prof. Milnes Marshall's "Outline Classification of the Animal Kingdom."

THE Geological and Natural History Survey of Minnesota has published as one of its Bulletins (No. 7) a volume on "The Mammals of Minnesota." It is described on the title-page as "a scientific and popular account of their features and habits." The work is illustrated with twenty-three figures and eight plates.

A WORK on the "Geology of the Eureka District, Nevada," with an atlas, by Arnold Hague, has been published by the United States Geological Survey. It forms the twentieth volume of the Survey's "monographs." The author explains in the preface that the work is purely geological in its scope and is mainly a careful study and survey of a comparatively small block of mountains, which may be designated the Eureka Mountains, but which should not be confounded with the Eureka mining district, as several other well-known but less important mining districts lie wholly within the same mountain area.

THE first part of M. E. Burnat's important *Flore des Alpes Maritimes* has just been published.

A REPORT of the results so far obtained from Bornmüller's botanical travels in southern Persia is published in the *Mittheilungen* of the Thuringian Botanical Association.

DR. P. H. MELL has prepared for the U.S. Department of Agriculture a valuable report on the climatology of the cotton plant.

AN important series of well-crystallising double halogen salts of tellurium with potassium, rubidium, and cæsium, have been prepared by Mr. H. L. Wheeler, and are described in the current number of the "Zeitschrift für Anorganische Chemie." They correspond to the general formula M_2TeR_6, where M represents potassium, rubidium, or cæsium and R chlorine, bromine, or iodine. They all crystallise in octahedrons belonging to the cubic system, in this respect resembling the platino-chlorides and other kindred double halogen salts of that type. The crystals of the chlorides possess a bright-yellow colour, those of the bromides various shades of deep red, while those of the iodides are quite black and opaque. In order to prepare the chlorides, tellurium is converted into tellurious acid by means of nitro-hydrochloric acid; the solution is evaporated to dryness, and the residue dissolved in hot hydrochloric acid. Upon adding to the solution of tellurium tetrachloride so obtained an aqueous solution of the chloride of the alkali metal, a crystalline precipitate of the double chloride is obtained. In the case of the cæsium salt, Cs_2TeCl_6, a precipitate is obtained even in very dilute solutions, owing to the difficult solubility of the salt. Upon boiling the precipitate dissolves, and on cooling brilliant little yellow octahedrons are deposited. The presence of excess of either cæsium chloride or tellurium tetrachloride is quite immaterial; indeed, the salt may be recrystallised from a solution of either. Water at once decomposes it, with production of a voluminous white precipitate of tellurious acid H_2TeO_3. It is only stable in solution in presence of a little free hydrochloric acid. Concentrated hydrochloric acid precipitates it from solution in the form of microscopic octahedra. The rubidium salt, Rb_2TeCl_6, is more soluble so that precipitation only occurs in concentrated solutions. The crystals, moreover, are usually much larger than those of the cæsium salt. The potassium salt, K_2TeCl_6, is much more soluble, and is even deliquescent. An excess of tellurium tetrachloride is necessary in its preparation, and it is best obtained in good crystals by spontaneous evaporation of a dilute hydrochloric acid solution.

THE bromides are obtained by dissolving finely divided elementary tellurium and caesium bromide in dilute hydrobromic acid containing excess of bromine. In the preparation of the cæsium salt, Cs_2TeBr_6, the solution is effected at a moderately elevated temperature, and the concentrated solution deposits large brilliant red octahedrons of the salt upon cooling. The rubidium salt, Rb_2TeBr_6, is readily obtained in magnificent deep red octahedrons by spontaneous evaporation of the solution prepared at the ordinary temperature. In preparing the potassium salt, if a hot solution is made, octahedral crystals of the anhydrous salt, K_2TeBr_6 are obtained, but if the concentration is effected by spontaneous evaporation light red coloured rhombic crystals of a hydrated salt, $K_2TeBr_6 \cdot 2H_2O$, are deposited. The iodides are prepared by addition of the alkaline iodide to a solution of tellurious acid in hydriodic acid. The cæsium salt, Cs_2TeI_6, is so difficultly soluble that it was only obtained as a finely divided black powder. The rubidium salt, however, Rb_2TeI_6, is more soluble and is precipitated in microscopic black octahedrons. The potassium salt is deposited in the hydrated form, $K_2TeI_6 \cdot 2H_2O$, in long monoclinic prisms which lose their water of crystallisation at 100–115° and become converted into a dull black powder consisting of the anhydrous salt.

SIMULTANEOUSLY with the above work of Mr. Wheeler, Drs. Muthmann and Schäfer, of Münich, have been engaged in investigating the formation of double halogen salts of the alkali metals with tellurium and selenium, and in the current number of the "Berichte," an account of some corresponding selenium compounds is given. Analogous chlorides were found to be incapable of preparation in presence of water, but the corresponding potassium and ammonium selenium

bromides have been obtained in good crystals. When selenious acid is dissolved in hydrobromic acid and to the solution of selenium tetrabromide thus formed a solution of potassium bromide is added, and the mixture evaporated and allowed to cool, a deep orange-coloured precipitate is produced, consisting of small regular octahedrons of potassium selenium bromide, K_2SeBr_6. These crystals are decomposed by water like those of the tellurium salts previously described, a colourless solution being obtained which contains selenious and hydrobromic acids and potassium bromide. They dissolve without decomposition, however, in dilute hydrobromic acid and separate from the solution again upon evaporation. The ammonium salt $(NH_4)_2SeBr_6$, is likewise readily obtained by employing ammonium bromide instead of potassium bromide. A precipitate of minute dark-coloured regular octahedrons is usually at once obtained upon adding the ammonium bromide, and the mother liquor after filtration yields by spontaneous evaporation beautiful garnet red octahedrons, modified by faces of the cube, which frequently exceed half a centimetre in diameter and exhibit a brilliant semi-metallic lustre.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include a number of the Lucernarian *Depastrum cyathiforme* (one individual exhibiting a lateral bud), several varieties of the Actinian *Thoë* (*Sagartia*) *sphyrodeta*, the Mollusca *Sepiola atlantica*, *Philine aperta* and *Æolidiella Alderi*, and species of the Cumacean genera *Diastylis*, *Iphinoë* and *Pseudocuma*. There has been no noteworthy change in the floating fauna. The following animals, in addition to the larger number of those already recorded, are now breeding:—the Actinian *Urticina felina* (= *Tealia crassicornis*), the Cumacean *Pseudocuma cercaria*, the Brachyura *Xantho floridus* and *rivulosus* and the Echinid *Echinus miliaris*.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂), a Lion (*Felis leo*, ♀) from South Africa, presented by Mr. Frederick Vaughan Kirby; a Mozambique Monkey (*Cercopithecus pygerythrus*, ♂) from East Africa, presented by Mr. Lewis Atkinson; a Sykes's Monkey (*Cercopithecus albigularis*, ♂) a Garnett's Galago (*Galago garnetti*) from East Africa, presented by Mr. Thomas E. C. Remington; a Diana Monkey (*Cercopithecus diana*, ♀) from West Africa, presented by Surg.-Major S. J. Flood; a Japanese Deer (*Cervus sika*, ♂) from Japan, presented by Mr. C. J. Lucas; two Emus (*Dromæus novæ-hollandiæ*) from Australia, presented by Mr. Charles E. Milburn; four Sociable Marsh Hawks (*Rostrhamus sociabilis*) from South America, presented by Mr. G. R. Gibson; two Madagascar Weaver Birds (*Fondia madagascariensis*) from Madagascar) presented by Mr. Ginn; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. W. B. Brett; a Radiated Tortoise (*Testudo radiata*) from Madagascar, presented by Mr. B. Smith; a Bonnet Monkey (*Macacus sinicus*, ♂) from India, (two Mexican Guans (*Penelope purpurascens*) from Central America, a Wattled Guan (*Uburria carunculata*) from United States of Columbia, deposited; a White-lipped Peccary (*Dicotyles labiatus*, ♂) from South America, an Orange-winged Amazon (*Chrysotis amazonica*) from South America, twelve Spotted Salamanders (*Salamandra maculosa*) European, purchased; a Reindeer (*Rangifer tarandus*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE (APRIL, 1893).—In *Comptes Rendus* for March 15 (No. 20) M. Deslandres gives a brief preliminary account of some of the main results that he has been able to gather from the photographs taken by him during the recent total solar eclipse. The instrumental equipment that he had, enabled him to obtain photographs of the corona, to study its spectrum, to examine the coronal light in the most refrangible part of the ultra-violet region, and to measure the rotation of the corona by the method of the displacement of lines in the spectrum. The coronal photographs showed luminous jets of a length equal to twice the diameter of the sun, while the general outline had a form somewhat usual at times of maxima spot frequency. With regard to the spectroscopic results, the large dispersion that was employed in one case was found to have been too great; but from the photographs taken with the small dispersive instrument at least fifteen new coronal and chromospherical lines have been discovered. Perhaps the most interesting results obtained relate to the rotation of the corona. The negatives showed the spectra of two points exactly on opposite sides of the corona, situated in the equatorial plane of the sun, at a distance equal to two-thirds of his diameter. The lines in the spectra indicated large displacements, which on measurement were found to correspond to velocities of 5 and 7 kilometres. The conclusion to be gathered from such a result as this is that the corona must travel nearly with the disc in its motion and thus be subject to its periodical rotational movement.

THE ECLIPSE OF APRIL, 1893.—It is very satisfactory to hear that the photographs taken by the English party situated at Fundium, on the west coast of Africa, have, on closer examination, turned out very excellent. There seems great reason also to believe that many old points may be cleared up, while hope is also entertained of raising some new ones.

FINLAY'S PERIODIC COMET.—A telegram from Kiel informs us that Finlay's comet has been found. It runs as follows:—

18 May, 16h. 15m. 6s., Capetown
R.A. 355° 30′ 18″ N.P. D. 95° 1′ 50″
Dim.

VARIABLE STAR NOMENCLATURE.—Now that a systematic means has been adopted for numbering the minor planets until their orbits are fully recognised, much unnecessary confusion has been avoided. Just as it was with asteroids so it is with variable stars, many stars being termed such although their variability has not been confirmed. To correct such errors and to eliminate various other sources of mis-notation, such as that of putting a catalogue letter in front of the constellation in which the star is situated, when another star in the constellation is so known in the star maps, Prof. Chandler adds a few notes with reference to the catalogue which will now soon be forthcoming (*Astronomische Nachrichten* 3161). He also gives a partial list of some of the letters that will be adopted to avoid further complexity.

JUPITER'S SATELLITES.—In this column, vol. xlvii., p. 518, we referred to the important work that was being carried on at Arequipa by Prof. Pickering with reference both to the telescopic appearances of Jupiter and his system of satellites. Since that time further observations, more especially of the satellites, have occupied his attention, and an account of them is given in the current number of *Astronomy and Astrophysics* (No. 115). The first investigation he undertook was to find out whether the rotations of the satellites on their axes were retrograde or direct. To do this the alternate lengthening and shortening of the discs were minutely observed, use being made of the revolution of the earth, since it is on this account that after opposition with *direct* motion of rotation a given phase will be presented earlier, and with retrograde motion a given phase will be presented later than if the observations had been made from the centre of the sun. Working with the first satellite it was found that a series of observations occupied about two hours, and upon the hypothesis of a *direct* rotation the synodic period was 13h. 3m. 25·8s., and upon a *retrograde* motion hypothesis, 13h. 3m. 10·8s. The conclusion of the discussion of the observations here given is that the rotation is probably retrograde. In the clear air of Arequipa, and with excellent instrumental equipment, Prof. Pickering has been able to make many quite unique observations. We have mentioned before the flattening of the disc of the second satellite when about to undergo an occultation. This observation has later been confirmed, and thus shown to be a genuine observed fact. The reappearance of the third satellite on January 27 has given perhaps a better series of observations of this atmospheric effect. When the satellite was half uncovered "it was noted that the cusps were distinctly rounded as in the case with the sun when

near the horizon, as seen from a high mountain peak." That Jupiter is not self-luminous, and that outside its cloud surface is situated a rare atmosphere capable of producing a measurable refraction, are two of the results of these observations, and taking the refraction at the cloud surface, the value $0''\cdot50 \times 0''\cdot05$ probably is not far from the truth.

THE MOON'S SURFACE.—Under the title of "The Moon's Face," a study of the origin of its features, we have before us a small book of fifty pages, containing the address, as retiring President, of Mr. G. K. Gilbert, before the Philosophical Society of Washington (*Bulletin*, vol. xii., pp. 241-292). After giving a short survey of the various theories that have from time to time been suggested as explaining the origin of the features on our satellite's surface, Mr. Gilbert has been led to put forward what he terms a "moonlet theory," which "not only harmonises with the varied details of crater character, but aids in the explanation, and even in the history, of the other features of the moon's surface." The hypothesis may be stated as follows:—Previous to the existence of the moon the earth was circled by a ring analogous to that which surrounds Saturn. The small bodies or satellites constituting this ring in time gradually coalesced, first into a large number of nuclei, and finally into one, this nucleus being our moon. The lunar craters are, to use Mr. Gilbert's own words, "the scars produced by the collision of those minor aggregations, or moonlets, which last surrendered their individuality." In discussing this hypothesis the inquiry is carried on three lines: an investigation of the ellipticity of the lunar craters, experimental investigation of the relation between the angle of incidence and ellipticity of impact craters, and of the orbital relations affecting the incidence angles of moonlets. With regard to some of the peculiar features of the lunar surface, let us briefly refer to some of the explanations given here. In the production of small craters small moonlets were employed, the cups being moulded as the result of collision. For large craters, greater moonlets are supposed to have been in action, the rims round the cups being raised partly by the overflow at the edges of the cup, or resulting in the upheaval of the surrounding plain in all directions. The central cone is accounted for by supposing that the top parts of the walls of the cup are so "weakened by the efforts of heating," that they consequently fall into the centre of the cup from all sides. In the region of the Mare Imbrium he supposes that a collision of great violence occurred, dispersing in all directions a deluge of material "solid, pasty, and liquid." The outrush from the Mare Imbrium thus introduces the elements necessary to a broad classification of the lunar surface. Smooth planes were produced by the liquid matter, parts were ground or sculptured by the solid matter, while some features were left entirely untouched. Such are one or two of the origin of surface features as put forward by Mr. Gilbert in his moonlet theory. That they are ingenious and lack not interest is true, but that the hypothesis itself is likely to be received with anything like favour seems very doubtful, since our present knowledge of the way nature works shows us that the last minor aggregations or moonlets could not very probably act in the way indicated above, because the state of the nucleus about that time would be one of intense heat in consequence of the collisions, and therefore would not be capable of receiving lasting impressions as required by the hypothesis.

AMÉDÉE GUILLEMIN.—It is with great regret that we have to record the death of M. Amédée Guillemin, which occurred recently in France. Many of our readers will have read the most interesting and valuable books which he wrote, setting forth scientific facts in a popular light. Of his many writings perhaps that which is most familiar to us are the volumes entitled "The Heavens" and "The Forces of Nature," as translated into English, and it is only quite lately that we had occasion to notice a small volume, evidently his last work, dealing with astronomical subjects, and entitled "L'Autres Mondes."

GEOGRAPHICAL NOTES.

LIEUTENANT R. PEARY, the explorer of North Greenland, has been reluctantly compelled to relinquish his projected lecturing tour in Europe, as all his time must be devoted to preparations for his new expedition toward the North Pole, which he hopes to commence this summer.

THE Governments of Sweden and Denmark have entrusted Prof. Otto Pettersson with the planning and direction of a series of simultaneous observations on the physical condition of the Skagerrack, Kattegat, and Baltic Sea. These observations are to be made on four days, three months apart, and commenced on May 1, 1893. Simultaneous observations between the Moray Firth and the north of Shetland would greatly enhance the value of the Scandinavian results, and it is possible that the Fishery Board for Scotland may undertake this work, at least on some of the observing days.

CAPTAIN RICHARD PIKE, well known as an Arctic navigator in recent American expeditions, died at St. John's, Newfoundland, in the beginning of May. In 1881 he conveyed the Greeley expedition to Lady Franklin Bay, and would have brought relief to the party, and saved the gallant explorers from their terrible experiences of starvation in 1883, had he not on that occasion been put under the orders of a United States cavalry officer, whose mismanagement ruined the expedition. Captain Pike's last Arctic work was the transport of Peary's expedition to McCormack's Bay, and his return for them in the sealer *Kite*. He had the reputation of being the best practical navigator of the Newfoundland Sealing Fleet, and his experience will be missed in connection with Lieutenant Peary's new expedition, which Captain Pike was to have taken north this summer.

THE anniversary meeting of the Royal Geographical Society will be held on Monday, the 29th, at 2.30 p.m. From the circular calling the meeting we observe that a very considerable change in the composition of the Council is contemplated. The President, Sir M. E. Grant Duff, does not seek re-election, in the hope, as he hinted at the anniversary dinner, that his "leap into the gulf in the cause of women" will heal the recent dissensions in the Society, and enable the scientific work in which it is engaged to be carried on without interruption. Mr. Clements Markham, F.R.S., has accepted the nomination of the Council as President. Captain Wharton, R.N., F.R.S., is proposed as a new Vice-President, and the following, amongst other names, are proposed as new members of Council:—Admiral Lindesay Brine, General T. E. Gordon, author of "The Roof of the World;" Mr. G. S. Mackenzie, of the British East Africa Company: Colonel C. M. Watson, and Mr. W. H. Hudlestone, F.R.S., President of the Geological Society. These nominations are subject to the approval of the annual meeting, which is expected to be unusually large and representative.

BACTERIA, THEIR NATURE AND FUNCTION.[1]

A WELL-KNOWN English writer a short time ago informed the public that Prof. von Pettenkofer, the distinguished veteran in sanitary science in Munich, expressed the opinion that "the atmospheric envelope of this globe is at present in a bacillophil humour." Expressions such as these have been repeatedly used in one form or another, some more, some less witty; the intention being, of course, to convey an exaggerated impression of the frame of mind of over-zealous enthusiasts. By such expressions more or less distinguished speakers and writers have been enabled to exhibit the smartness of their phraseology. Thus one distinguished professor relieved the anxiety of his students by the jocular observation that idleness and laziness will probably be found to be due to a specific bacillus, while another no less profound writer enunciated that crime and inebriety are probably due to bacilli. With regard to the distribution of bacteria, as well as with regard to their action, we meet with statements which are almost made humorous by smartness of exaggeration. Under the cover of the title "Science Notes," one of the London papers offered to its readers for breakfast the following palatable dish:—"In a grain of butter you have 47,250,000 microbes; when you eat a slice of bread and butter, you therefore must swallow as many microbes as there are people in Europe." Here it ought to be stated that a grain of solid matter of *London sewage* contains only a small fraction of this number of microbes. But leaving these silly exaggerations and those grotesque sayings to their authors for

[1] Lecture delivered at the London Institution, on February 27, 1893, by E. Klein, M.D., F.R.S., Lecturer on General Anatomy and Physiology at the Medical School of St. Bartholomew's Hospital, London

further improvement, it is nevertheless well established that a considerable number of phenomena in nature are intimately associated with bacterial life. The world of bacteria is comparable to an unseen flora which, in variety of character, of activity and importance in the economy of nature, compares with the visible flora, and in its extension and area of distribution is as great as, in some respects greater than, that of the visible vegetable and animal kingdom. Though unperceived by the unaided eye, this bacterial world forces itself, by its multifarious activity, continually on our attention; it comes into prominence by the vast effects, the slow but far-reaching results which it produces on man, animal, and plant, for good and for evil, in life and in death. Some of these actions I shall have the honour to bring before you this evening, and you will see that while there are bacteria whose actions are undesired and not conducive to the well-being of man or animals, there are others which are of the greatest service both to them and to plants, and are an essential and integral part in the economy of nature.

I spoke just now of the bacterial world as of an unseen flora; I meant by this a part of the vegetable kingdom not perceived by the unaided eye, though, as you will see, it is easily brought to perception by a variety of means. The individuals that constitute the bacterial world are, as is no doubt known to you, of such extremely minute size that only by the aid of the microscope can they be seen, their size being often less than $\frac{1}{25000}$ or $\frac{1}{50000}$ part of an inch, rarely more than $\frac{1}{5000}$ part of an inch. They are spoken of as having the character of plants, because the elements, like those of a plant, are invested in a sheath of cellulose, within which is contained the essential part, the living protoplasm, the bacterial individuals being in fact comparable to unicellular plants, in which, however, no definite cell nucleus has been hitherto demonstrated. It ought, however, to be mentioned that various observers have attempted to show, and, by complex methods of staining, have succeeded in showing in some bacterial species the existence of parts which resemble, and which are considered as comparable to, the nucleus forming an integral part of the typical vegetable cell.

In speaking of bacteria as of plants there are other than morphological characters which guide us in this designation; bacteria resemble plants in this essential, that they possess the power to build up, out of simple organic compounds, the most complex substances such as the protoplasm of their own bodies. There are known not a few bacterial species which grow and multiply, *i.e.* which build up their highly complex nitrogenous albuminous substances at the expense of relatively simple nitrogenous bodies, such as ammonium tartrate, urea and allied substances, or which can do this even by the absorption of free nitrogen of the air. Other species require for their growth and multiplication as complex nitrogenous substances as the animal body itself, and like this latter are capable of breaking them up into simpler combinations. Pathogenic bacteria—many of the species concerned in the decomposition and putrefaction of albuminous substances—belong to this group.

All bacteria multiply by division; hence their name, schizomycetes, or fission-fungi, the typical process of multiplication consisting in the enlargement of an individual, and in subsequent splitting into two by fission, at the conclusion of which process two new individuals are the result, each of them capable of enlarging and again dividing in the same way into two, and so on. But it can be easily shown by comparative observations and examination of suitably prepared specimens of artificial cultures of the different species that not seldom the process of multiplication does not follow this line.

I show you here a lantern slide of a microscopic specimen of one of those species which, owing to the spherical or nearly spherical form of the elements, is called a coccus, or micrococcus; and owing to the manner of growth in clusters and continuous masses, is called a staphylococcus; this microscopic specimen has been obtained by the method of making "impression preparations," that is to say, by means of a thin glass pressed on to a recent, *i.e.* a young colony or colonies growing on the surface of a solid medium, an exact impression is obtained of the growth, and a good and correct insight is obtained of the manner in which the colony enlarges, and the way in which the individuals constituting the colony grow and multiply. You see in this photographic representation that there are a good many individuals many times (4–10 times) as large as others, that some of these large elements are uniform, while others show just the indication of a transverse fissure by which the large element is dividing; still others show two fissures at right angles, by which the big element becomes divided into four smaller ones. But you see also the majority of cocci are only minute dots, some in pairs, others in clusters, the former looking like two demilunes separated by a straight clear line; in fact, this latter appearance denotes the typical manner in which one coccus, having first enlarged a little, divides into two small elements. But the presence of the huge elements mentioned above tells us also that one coccus may go on growing to a very large size without dividing, and having reached this huge diameter, then commences to divide, first into two, then into four, eight, and sixteen individuals of the typical size.

I show you here an impression preparation of a recent colony of another species (*Bacillus coli*), the individuals of which are rod-shaped or cylindrical, and are what are called typical bacilli. Here the great majority of the individuals are of cylindrical shape, and of a fairly uniform size; a few only are shorter, and arranged in the form of a dumb-bell, indicating that one of the longer individuals has by fission split up into two smaller individuals. But if you look at a third impression preparation, of which I here show you a photograph (Proteus), you will see that while there are a few chains of cylindrical bacilli, indicating successive division of the individuals and the new offsprings remaining joined end to end—thus constituting what is spoken of as a leptothrix—there are other threads in the colony which either show a division into cylindrical elements only imperfectly or not at all, appearing uniform and unsegmented threads; where the segmentation is imperfect the individuals are of very various lengths, some not longer than those typical bacilli in the first-mentioned chains, others three and more times as long. These appearances indicate that the multiplication of the bacilli does not always take place in that typical manner in which it is generally represented, viz. one individual elongates a little, then splits up into two short individuals; but a bacillus may go on elongating till it reaches the manifold length of the typical rods, and having reached this great length then segments into a great number of cylindrical rods. This mode of multiplication can be made out not only in these impression preparations, but can be actually observed in the fresh condition under suitable conditions, *e.g.* on the warm stage.

That this mode of growth appertains not only to cocci and bacilli, but also to the third morphological group of bacteria, viz. the vibrios, or spirilla, is ascertained by the fact that often one vibrio, *i.e.* a more or less curved rod-shaped individual or a comma-shaped bacillus, grows into a uniform homogeneous spiral or wavy thread, which is capable of splitting up into a number, *i.e.* a chain of comma-shaped vibrios.

We have then the typical mode of division, by which one individual, a coccus, or bacillus, or vibrio, as the case may be, slightly enlarges, and then by fission divides into two; or an individual continues to grow to abnormal size or length, and then splits up into a series of individuals of the typical size; this latter mode of multiplication implies a deficiency of fission for the time being, and is not, as far as can be made out, due to any abnormal conditions affecting the growth, for in many species this occurs in recent and active colonies under conditions which in all other respects must be pronounced as favourable for growth and multiplication.

Another interesting appearance, shown by some species of bacteria, is generally ascribed to degeneration or involution, *i.e.* the bacteria assume peculiar abnormal shapes stated to be due to abnormal influences, insufficient or unfavourable soil, unfavourable temperature, &c., &c.; but while it is true that such influences do produce abnormal shapes, disintegration, &c., there are certain changes in shape that are observed in some species of bacteria while growing under perfectly favourable conditions and with the normal rapidity, and which are anything but degenerating.

A recent colony of the bacillus anthracis, like the photograph I show you here, growing on nutritive gelatine, is made up of twisted and convoluted threads of cylindrical rods, which threads are seen to shoot out and to extend like filaments from the margin of the colony. Now, you notice in the next photograph that instead of these filaments being made up of the typical cylindrical rods the former consist of relatively huge spindle-shaped or spherical masses many times the diameter of the typical rods. The threads of this colony are perfectly active, and are growing with vigour and in perfectly normal circumstances as regards soil, temperature, and all other known conditions. As a matter of fact, a few days later, as comparative specimens show, all threads may be, and as a rule are, again of

the typical aspect, *i.e.* uniform threads and chains of rod-shaped elements.

Another photograph which I show you here is from a colony of the bacillus of diphtheria. Here also you notice the appearances already mentioned of the anthrax bacilli, viz. shorter or longer filaments, in which some of the elements show a conspicuous enlargement: pear-shaped, spherical, or club-shaped. Such forms are not involution forms: they occur in vigorous and actively growing young colonies.

A still further illustration, and one of great importance, is shown by this photograph, illustrating a similar change of the tubercle bacilli. This change has now been confirmed by several independent observers. The typical tubercle bacilli of human or bovine tubercle and of early cultivations are cylindrical rods. In cultivations of long duration but still actively growing you notice forms which are more filamentous, and, as in the present illustrations, are branched filaments with club-shaped enlargements.

From all this the conclusion is justified that in all these cases of bacilli the typical cylindrical bacilli show occasionally an indication that reminds one of forms belonging to the higher or mycelial fungi, in which the growing filaments remain unsegmented and become thickened and even branched. These thickened, branched, and club-shaped forms of the bacilli would correspond to an atavism, and would recall a probable former fungoid phase in the evolutional history of these bacilli.

The next point to which I wish to call your attention is the rapidity with which multiplication of the bacteria takes place. This differs according to the amount and nature of the nutriment or soil on which they grow, and to the temperature. While some bacteria multiply even at lower temperatures at a great rate, others do so only at higher temperatures. But in order to give you an idea of the power and the rate of multiplication I may mention the following:—Direct observations show that the rate at which bacteria divide at a temperature of 20°C. varies from eighteen minutes to thirty minutes or a little longer, and at higher temperatures correspondingly faster. A tube of nutrient broth was inoculated with a trace of the growth of a staphylococcus (*Staphylococcus pyogenes aureus*), the number of cocci introduced into the tube having been previously determined to be 8 per cubic centimetre. The tube was then kept at 37°C.; in the first twenty-four hours the cocci had multiplied to 640,000 per cubic centimetre; in the second twenty-four hours to 248 millions per cubic centimetre, and in the third twenty-four hours to 1184 millions per cubic centimetre.

A point of interest is the motility exhibited by some bacteria. In some species most, in others comparatively few, individuals show active locomotion, spinning round and darting to and fro; in many other species no motility is observed. In the motile species it is known that this motility is due to the presence and active motion of cilia or flagella, and these have been seen and photographed in former years in some of the larger forms, but only within recent years has it been possible, by means of new methods (Löffler), to actually demonstrate in the smallest forms these flagella, and here the remarkable facts have been shown that while some possess only one flagellum at one end, in other species the bacillus possesses a bundle of them, or is covered with the flagella on its whole surface. I show here some photos of the flagella, one possessing two flagella at one end (spirillum volutans), the other (cholera bacillus) one at one end, and the third (typhoid bacillus) is covered with quite a number of flagella.

A not less interesting point is the formation of spores: the only trustworthily ascertained mode of spore formation is that which is called endospores, as is shown in the following photograms; a bacillus at a certain phase develops in its protoplasm a minute glistening granule, this increases in size and becomes oval, while the rest of the substance of the bacillus becomes pale, swells up and gradually degenerates and disappears, leaving the fully formed oval bright spore free. These spores are of great resistance to temperature, chemical obnoxious substances, drying, &c., so that even after long periods and various adventures, when again brought under proper and suitable conditions, they are capable of germinating into the bacilli. These then grow and divide and continue to do so, producing new crops. Non-sporing bacteria are for this reason more liable to succumb in the struggle for existence, although many species of non-sporing bacilli have such a vast power of multiplication and are so little selective in their requirements that they manage to keep their crops perpetually going; some notorious putrefactive cocci and bacilli belong to this class. Having now mentioned the essential features in the morphology of bacteria, as far as is possible in the limited space of time at my disposal, I proceed to give you a short summary of some of the most important activities which bacteria exhibit.

Bacteria causing Decomposition of Albumen.

Foremost in importance and vastness of result is the action which certain species of bacteria have on albuminous matter, an action which is termed *putrefactive decomposition of albumen*, animal or vegetable. All organic matter when deprived of life is resolved into simpler compounds, is broken up into lower nitrogenous principles, like leucin, tyrosin, indol, phenol, &c., of which the ultimate products are ammonia, nitrites, and nitrates. The plant, it may be said in a general way, builds up albuminous matter from nitrates, this albuminous matter it is which forms the protoplasm of its cells, this albuminous matter it is which serves as nitrogenous food for animals; these again supplying the food for other animals and man. In the living body of these the albuminous matter becomes broken up, yielding nitrogenous principles like urea and allied substances, which again, after further oxidation in the soil and in water, serve to supply nitrates to the plant; but also the bodies of animals and plants after death form a large stock from which by a long chain of processes, induced and sustained by micro-organisms, lower nitrogenous compounds, and ultimately ammonia and nitrates are produced, from which the living plants principally draw their nitrogen.

From this it is evident that the vegetable kingdom is dependent for its nitrogen chiefly on processes by which from the albumen of dead organic matter, by the activity of micro-organisms, in the first place lower nitrogenous principles and ultimately ammonia, and in the second place, also by micro-organisms nitrites and nitrates are formed. Now, the micro-organisms which are capable of producing the first series of decompositions of dead albuminous matter form, so to speak, the first army of attack; it is this army which, while multiplying at the expense of albumen, decomposes it, and thereby is instrumental in changing it into lower nitrogenous principles such as leucin, tyrosin, indol, and ammonia. Amongst the large number of species of putrefactive bacteria I will describe two only, which by their great distribution may be considered as playing a very important part in this decomposition of albumen. The first is the species known as *Proteus vulgaris*, the second is the *Bacillus coli*.

(*a*) *Proteus vulgaris.*—This species is the common putrefactive organism; it is almost invariably present in dead and decaying albuminous matter; it is the organism which in dead animals and man plays the principal part in the destruction and resolution of the body; it is present in the cavity of the normal intestine; it is found in connection with effete and dead matter occurring in the body in health and disease; it has a wide distribution in nature, and is present wherever organic matter happens to be in a state of putrescence; it is liable to pass from this and to be transmitted to other putrescible matter by air currents, by dust, by water, by human contact or otherwise, and then to set up in this new organic matter the same state of putrescence. The same applies to the bacillus coli, which has also a very wide distribution, and which is in most instances associated with putrefaction and decomposition of albuminous matter; it is a normal inhabitant of the human and animal intestine, and from here often passes into the soil, water, and air.

These two species of organisms may be considered then as being of great importance in the destruction and resolution of putrescible matter, in short of dead albuminous matter.

I show you here photographs of these two species as they appear in artificial cultures, under various forms of cultivation, and under the microscope under a magnification of 1000. Both these species are motile bacilli.

The *Proteus vulgaris*, as its name implies, presents itself in forms so varied, that it is at first sight difficult to recognise them as belonging to one and the same species: coccus forms, short ovals, short and long cylinders, homogeneous long threads, and even spiral forms. But by artificial cultivation by exact methods they can be shown to belong to one and the same species; and it can also be shown that under particular conditions of cultivation the bacillus almost invariably shows itself as cylindrical and thread-like forms; whereas under other conditions it assumes the character of cocci and ovals. The photographs which I

show you here give an exact representation of these cylindrical and thread-like forms observed in early gelatine plate cultures; later on, when the growth has proceeded for some days, and the gelatine has almost entirely become liquefied, the majority of the individuals are very short—either coccus-like or short ovals.

It is on account of this unstable or protean character of its form that Hauser gave it the name of Proteus, and being the common microbe of putrid decomposition, he called it *Proteus vulgaris.*

This organism, as a first and important action, peptonises albumen and liquefies and peptonises gelatine; then this peptone is decomposed, yielding, amongst other substances, leucin, tyrosin, indol, skatol, phenol, and further, ammonia.

(*b*) *The Bacillus coli.*—The normal inhabitant of the intestine of man and animals is another powerful albumen decomposing microbe, but, unlike the proteus, it decomposes albumen without first converting it into peptone; it therefore does not liquefy gelatine like the proteus; it rapidly decomposes albumen, forming indol and allied bodies, and even ammonia.

Bacteria causing Ammoniacal Fermentation of Urea.

In connection with these true putrefactive bacteria I have to mention a group of bacteria which, though not strictly connected with decomposition of albuminous matter, play an important part, inasmuch as their action supplements that of the former, the group in question consisting of species which can change urea and allied substances into ammonium carbonate. This action is generally and justly considered of the nature of a ferment or hydrating action, like that of other organised ferments to be presently described. But we mention this group here because by changing urea into ammonium carbonate it prepares, in one sense, the way for the action of certain other bacteria which, by oxidising ammonia into nitrites and nitrates, are the direct food-providers for the vegetable kingdom. Urea and allied substances, as stated above, are the last products of albuminous metabolism in man and animals, and therefore form an integral part of the material destined for the soil in which the plants of our gardens and fields live and thrive. I show you here one of the species of this group—for there are several—the *micrococcus ureæ;* this is a coccus growing as a white staphylococcus, and forming connected masses in the natural or artificial culture media; it does not liquefy gelatine, grows extremely rapidly at higher temperatures.

The photographs give you an idea of the character of this organism in plate, in streak- and stab-culture, and in microscopic specimens; in these latter you notice that neither in size, nor arrangement, nor mode of division does this microbe show anything that would distinguish it from other species of staphylococcus; its action on urea being its chief distinguishing character, being capable of converting it into ammonium carbonate.

At present it is well established that nitrogenous principles like indol, phenol, and ammonia are produced during the decomposition of albumen by proteus, bacillus coli, and other putrefactive bacteria; and, further, that substances, as indol, phenol, and the like, are, by the activity of certain other bacteria not yet sufficiently investigated, converted into ammonia. We have now traced the decomposition of albumen down to ammonia, and in this condition it is subjected in the soil to the action of the *nitrifying bacteria*—that is, bacteria which oxidise ammonia and convert it into nitrites and ultimately into nitrates; these bacteria complete then the series of processes by which the nitrogen ultimately returns from where it started. It started as nitrates in the soil surrounding the roots of plants, and as nitrates it ultimately again finds itself in the soil; first it had been used by the plant in order to build up its albumen, then as vegetable albumen it represents the food of animals; in these it serves to build up the protoplasm of the animal body, from which it passes as food for carnivorous animals. The albumen of animals or plants becomes decomposed by putrefactive bacteria, the ultimate products of this, ammonia, becoming converted by the nitrifying bacteria of the soil into nitrites and finally into nitrates. "From earth to earth" expresses the beginning and end of this wonderful migration and change!

Nitrifying Bacteria.

Schlœsing and Muntz were the first to show that the conversion of ammonia into nitrates in the soil is most probably caused by micro-organisms, but not till the researches of Warington, Winogradski, and P. Frankland, were these micro-organisms isolated and more carefully experimented with. Warington, and particularly Winogradski, have shown that there are two species of bacteria which play an important part in these processes, one species converting ammonia into nitrites, the other these finally into nitrates. I show you here some lantern slides of Winogradski, in which these two species are well shown; the slides are of preparations of artificial cultivations, in which Winogradski has been extremely successful. These two species (the nitrous and the nitric organism) are minute rod-shaped or oval bacteria; when in the act of dividing, they form short dumb-bells; the nitrous organism is larger than the nitric, but both show forms which possess celia, and which therefore are possessed of motility. Winogradski has by artificial cultivations obtained both these species in large quantities, and, on testing them on liquids of suitable composition, found that the one is capable of converting ammonia into nitrites, the other these latter into nitrates. There can then be no doubt that the problem of the manufacture on a large scale of these nitrifying microbes, so important for agriculture, must be considered as solved.

Bacteria of Leguminosæ.

I have now to introduce to your notice a group of organisms which, like the former, are of interest and importance to the vegetable kingdom, at any rate to one portion of it, viz. the plants belonging to the leguminosæ.

Hellriegel and Wilfarth had shown that the excess of nitrogen in leguminosæ is obtained from the atmosphere by the instrumentality of bacteria in the soil around the roots of the leguminous plants; that these bacteria "fix" the free nitrogen contained in the soil, derived, of course, from the atmosphere; and that if the soil be sterilised, by which the bacteria are killed, no fixation of nitrogen can take place, and the growth of the leguminous plant remains appreciably attenuated. The roots of leguminous plants growing in the ordinary soil are known to possess numbers of nodular growths. These nodules have been thoroughly investigated by a large number of observers, and their importance in the process of fixing the nitrogen, and in the proper development of the plant, has been satisfactorily worked out; foremost amongst these stand the investigations of Prof. Marshall Ward, of Sir John Lawes and Dr. Gilbert, of Beyerinck, Prazmowski, Nobbe, and Frank. Beyerinck, then Prazmowski, and particularly Nobbe, have shown that the nodules on the roots owe their origin to the growth in the tissues of the root of certain bacteria, and it is these bacteria which are instrumental in fixing the free nitrogen. These bacteria represent well-defined species, and, as Nobbe has shown, differ for the different leguminosæ.

My friend Prof. Marshall Ward has been kind enough to supply me for examination with roots of lupines containing the nodules, and I show you here some photos as the result of this examination, illustrating the distribution in the tissue of the nodules of particular species of bacteria, then the character of these bacteria under cultivations, and their aspect and size in microscopic specimens. This species of bacilli is composed of motile cylindrical rods, which, cultivated in gelatine, liquefy this, and produce in the liquefied gelatine a peculiar greenish fluorescent colouring; on agar they also produce this colouring; the nature of the young colonies in plate cultivation, their manner of spreading and swarming, are well shown in these photographs.

Chromogenic and Phosphorescent Bacteria.

Time does not permit of more than a passing allusion to those remarkable species of chromogenic bacteria which have the power to produce pigments, either pigments which become dissolved in the medium in which these bacteria grow, or remain limited to the substance of the bacteria themselves. Species of bacteria there are which produce pigments of scarlet red, orange, yellow, yellow-green, green, greenish-blue, blue, violet, or pink colour. The nature of these pigments and the meaning and object of their formation are still shrouded in a good deal of mystery, though Erdmann and Schrötter showed long ago that many points of similarity exist between some of these pigments and certain anilin colours. I show you here cultivations of some of those chromogenic bacteria, and in a diagram the spectrum of one species, viz. of the *Bacillus prodigiosus;* this is the more common of the chromogenic bacteria, being occasionally present in water and in air. The pigment is soluble in alcohol, though only to a limited

degree, and when the spectrum of such a solution is examined it is seen to present a characteristic absorption-band in green; the spectrum of a watery distribution of these bacteria shows two bands: one narrow one in green, the other broader in greenish-blue; both are less deep than the single band of the alcoholic solution.

Nor have I sufficient time to do more than allude to another remarkable group of bacteria, which comprises several species, all having the power to produce luminosity of themselves and the medium in which they grow. These phosphorescent bacteria have been long known (Pflüger) to be concerned in the production of the phosphorescent condition of decomposing sea fish, but within recent times Ludwig, Fischer, Katz, and particularly Beyerinck have studied more in detail the conditions under which these bacteria grow, and have identified and cultivated several species. Dr. Beyerinck has kindly sent me one species of these phosphorescent bacteria. The elements of this species are short oval rods, often dumb-bells; they grow in fish broth, and when the growth becomes conspicuous to the unaided eye it is luminous when viewed in the dark. I show you here some cultures which, as you see, when I place them in the dark, show a beautiful phosphorescent appearance. The phosphorescence is more or less limited to the surface layer, that is the one in contact with the oxygen of the air; in the depth it is absent, but when shaking the flask the phosphorescence appears also in the depth.

Fermentation.

I have mentioned, in connection with a previous group, bacterial species which have the power to change by hydration urea into ammonium carbonate, a change which is called a fermentative action. Changes similar to these are caused by micro-organisms in many processes playing an important part in industries. Amongst these changes I may mention one in particular, the souring of milk. There are a good many others, the viscous or mannit fermentation, the butyric fermentation, the indigo fermentation, the dextran fermentation, the acetic acid fermentation, and others, but time does not permit me to describe more than one, viz. the common bacterium lactis. I show you here a number of photographs of the bacterium lactis under cultivation, and as seen under the microscope. It is a minute oval bacterium, which multiplies with great rapidity, and which, introduced into milk, turns this sour in 12 to 24 hours at the ordinary temperature; when sterile milk is inoculated with this bacterium and kept in a warm place at a temperature of 60° to 65° F., the milk is found solid and curdled before 20 or 24 hours are over, and in this curdled milk large numbers of the bacterium lactis are present either as dumb-bell ovals or as short chains. When a needle is dipped first into such curdled milk and then into normal milk, the same coagulation with the same appearances takes place in the latter. When a plate cultivation of such milk is made it is seen that a large number of colonies all of the same character are developed, which colonies are made up of the bacterium lactis; through however numerous generations this organism is cultivated in artificial cultivations,—it grows well on nutritive gelatine to which whey or only lactic sugar has been added—and if then transferred to fresh milk, it always produces this souring and curdling; that is to say, it changes lactic sugar into lactic acid, and as this is being formed it coagulates and precipitates the casein of the milk. With a trace of milk that has gone naturally sour—that is to say, to which the bacterium lactis has found entrance, and in which by its multiplication it has produced curdling, any amount of normal milk can be successively turned sour and curdled. The bacterium lactis is not by any means a rare organism; it is widely distributed, and can at any moment, in dairies and other places, through impurities of the utensils, by dust, &c., find access to milk which would soon succumb to its attacks; when, for instance, in dairies or in one or another locality the milk has a frequent tendency to turn sour, this means that the bacterium lactis has taken firm footing in such a locality. It is well known that only extreme measures of cleanliness, thorough boiling of all utensils and vessels, cleaning of walls and floors can banish or reduce it. In this the analogy with an epidemic of an infectious disease is obvious. Just as in an epidemic, every susceptible individual to which the contagion has had access becomes smitten by infection, and just as in an epidemic the contagium of the disease, being of wide distribution, and, having taken a firm hold of the locality, attacks an increasing number of individuals, and thus causes the epidemic—so also in the case of the bacterium lactis: when this has taken a firm hold of, and has acquired a great distribution in, any locality, any sample of milk (*i.e.* susceptible individual) may take the infection, either by coming in contact, directly or indirectly, with a trace of the milk already infected, *e.g.* by being placed in vessels in which infected milk has been kept previously, or becoming infected through dust charged with the bacterium lactis, or coming in contact with water poured from a vessel in which traces of the microbes were still left. All this finds its complete analogy in the case of an epidemic infectious disease. The fermentative processes due to microbic activity, and playing an important part in industries (alcoholic and other fermentations), illustrate in a very striking manner some of the essential features observed in the nature, in the production, and in the spread of infectious diseases in man and animals. The fermentative processes, thoroughly established as being due to microbic activity by the researches of Pasteur, were by Pasteur, and others after him, used as illustrations of the way in which infectious disorders in man and animals arise, and it was exactly these considerations which led Pasteur to his brilliant studies of these diseases, the results of which studies have been of such signal service in sanitary science in general, and in the prevention of infectious diseases in particular.

In the fermentative processes studied by Pasteur and others it was shown that each specific fermentative process is due to the growth and multiplication of a specific microbe. Just the same is the case with the infectious diseases—when from a substance which is in the process of fermentation, a trace containing the particular microbe is introduced into fresh fermentible substance, this latter undergoes the same fermentation; further, it is shown that, however great the number of accidental non-specific bacteria which may be introduced at the same time, unless that particular bacterium be present amongst them, the specific fermentative change does not ensue. The same is the case with infectious diseases: the number of non-specific bacteria in water, dust, air, various common articles of food, &c., is sometimes great, but no amount of these would set up any of the infectious diseases, like cholera or typhoid fever, tetanus or diphtheria; in order to do so there must be amongst them the particular microbe of cholera or typhoid fever, &c. Again, in each fermentative process the substance which is to undergo the fermentation must be susceptible of the particular fermentation: a substance that contains sugar can undergo the alcoholic fermentation, a substance that contains alcohol can undergo the acetic acid fermentation, &c. The same is the case in the infectious diseases: an individual must be susceptible to the disease, though it is not quite clearly established what the meaning of this is. Further: just as in the fermentative process the susceptibility of the substance alone is not sufficient, is only a preliminary condition, the actual infection with the specific microbe being the essential, so also in the infectious disease: in order that a susceptible individual should become the subject of the disease it is essential that the specific microbe should be present and should find entrance into this susceptible individual. Just as little as a particular condition of the atmosphere, of temperature, &c., is capable of producing the souring of milk, so also a particular atmospheric or telluric condition, season, or other external circumstances alone cannot produce an infectious disease. What is wanted in the first place is the presence of the bacterium lactis in the one, the specific pathogenic microbe in the other; atmospheric or telluric conditions may and do favour the more rapid multiplication and dissemination of the bacterium lactis or other specific microbes, but without the presence of the specific microbes these processes could not take place. "Thunder in the air" could not turn the milk sour, could not make meat tainted, could not turn beer or wine sour, without the presence of the specific microbes, which by their presence and multiplication produce those undesired changes in these substances; the particular condition of the air could and would increase their rate of multiplication and distribution, and therefore increase the chances of infection of these substances and therefore a more conspicuous manifestation of the effects of the activity of those microbes, but it could not produce the microbes themselves.

Pathogenic Bacteria.

The different pathogenic bacteria connected with and causing the different infectious diseases have then the power of growing and multiplying within the infected individual and through the different poisonous substances—toxins—which they therein

produce, of causing the changes which characterise the particular disease.

I show you here photographs of a variety of such pathogenic bacteria, and you will see from them that both as regards the manner of distribution of these bacteria in the tissues of the infected individuals as also in their morphological and biological characters in artificial cultures, most of them are sufficiently distinguished from one another and from other non-pathogenie bacteria. In considering the general action of pathogenic bacteria we find that they may be grouped into (*a*) such as are entirely, so far as our knowledge at present goes, dependent on the living body of man or animals; these are endogenic bacteria or true parasites, for they do not appear to lead an existence independent of the living body: when, therefore, infection by them takes place, it takes place by direct transference from an infected individual to a new one; this is so in small-pox, in vaccinia, and in hydrophobia; (*b*) a second group comprises those which are capable besides a parasitic life, *i.e.* growing and multiplying within the animal body, to lead also an existence independent of the animal body; that is to say, they, like many other non-pathogenic bacteria, are capable of thriving in suitable materials in the outside world; such are anthrax and fowl cholera, asiatic cholera and typhoid fever, tetanus and diphtheria, and others. But also amongst these some can lead such an "ectogenic" life comparatively easily, while others do so only in a restricted sense; while, for instance, anthrax, tetanus, typhoid fever can lead such ectogenic life easily, *i.e.* growing and multiplying outside the animal body; others, like tubercle and glanders, do so only to a very small extent. The former are obviously the more dangerous to man and animals on account of their more ready distribution than the latter, of which the ectogenic existence is considerably restricted by various conditions, *e.g.* they require higher temperatures to grow at, they require a much more specialised nutritive medium than is generally attainable by them.

Time does not permit me to show you in detail the many and wonderful results obtained within a comparatively short recent period by a large number of workers, as regards the identification of many of the pathogenic bacteria, their habits of life, their mode of spread and infection; the way in which their action can be attenuated, their effects weakened, and such weakened cultures used for protective inoculations; the brilliant results achieved by Pasteur and many others in these protective and curative inoculations against anthrax, against fowl cholera, against tubercle, against hydrophobia, against tetanus and other diseases. But I will ask you to bear in mind that almost the entire study of bacteria, the exact methods first introduced by Koch and now universally used not only in regard to pathogenic bacteria, but in all other branches of bacteriology; the exact knowledge that we possess of some of the most important branches of hygiene: as the knowledge of the exact nature of contagium, its mode of spread, the means of disinfection, the methods of protective inoculation, and a hundred and one other important points have been the result of, and gained by, experiment on animals. Amongst the wilderness of misery, cruelty, and death inflicted by mankind on animals for gain, for sport, pleasure, and other similar objects, to decry, as some do, the use of a comparatively few animals for the sake of gaining knowledge of the most important and complex phenomena of life and of disease, and of securing power to apply this knowledge in the interest not only of mankind, but of the animals themselves, is apt to make one remember the words: "Ye blind guides! which strain at a gnat and swallow a camel," or the words, "Thou hypocrite! cast out first the beam out of thine own eye, and then shalt thou see clearly to pull out the mote that is in thy brother's eye."

SURGERY AND SUPERSTITION.

TO those unversed in the history of surgery it may come as a surprise that many of the appliances commonly regarded as the inventions of yesterday, are but the perfected forms of implements long in use. It is astonishing to find amongst the small bronzes of the National Museum at Naples, bistouries, forceps, cupping-vessels, trochars for tapping, bi-valvular and tri-valvular specula, an elevator for raising depressed portions of the skull, and other instruments of advanced construction which differ but little from their modern congeners. The invention of such instruments, and the skill displayed in their construction, presupposes a long period of surgical practice. We find, accordingly, that four hundred years before our era, Hippocrates was performing numerous operations bold to the verge of recklessness. Thus he was accustomed to employ the trepan not only in depression of the skull or for similar accidents, but also in cases of headache and other affections to which, according to our ideas, the process was singularly inapplicable. Strangely enough, the Montenegrins are, or recently were, accustomed to get themselves trepanned for similar trifling ailments, and it is probable that in both instances the procedure was but the surviving custom of primeval ages. That such operations were then performed Dr. Robert Munro, in his admirable article upon prehistoric trepanning in the February number of the *Fortnightly Review*, conclusively shows. His paper records a strange blending of the sciences of medicine and theology in their initial stages; for, whilst he makes it clear that during the neolithic period a surgical operation was practised (chiefly on children) which consisted in making an opening through the skull for the treatment of certain internal maladies, he renders it equally evident that the skulls of those individuals who survived the ordeal were considered as possessed of particular mystic properties. And he shows that when such individuals died fragments were often cut from their skulls, which were used as amulets, a preference being given to such as were cut from the margin of the cicatrised opening. The discovery arose as follows. In the year 1873 Dr. Prunières exhibited to the French Association for the Advancement of Science an oval cut from a human parietal bone, which he had discovered in a dolmen near Marvejols, embedded in a skull to which it had not originally belonged. His suggestion that it was an amulet was confirmed on the discovery of similar fragments of bone grooved or perforated to facilitate suspension. When Dr. Prunières's collection was examined by Dr. Paul Broca he pointed out that that portion of the margin of the bone which had been described as "polished" owed its texture to cicatricial deposits in the living body, and that, where these were wanting, death had ensued before the pathological action was set up, or the operation had been *post mortem*.

These discoveries led to widespread investigation, and to the production of trepanned skulls from Peru, from North America, and from nearly every country of Europe. These were not restricted to any particular race or period, but ranged from the earliest neolithic age to historic times, and included skulls of dolichocephalic and brachycephalic types.

The method of conducting the operation appears to have been to gradually scrape the skull with a sharp flint, though there is occasional evidence of its use in a sawing manner such as obtained when the ruder implement was superseded by one of metal. The process was almost exclusively practised upon children, probably on account of the facility with which it could then be accomplished, and possibly also as an early precaution against those evils for which it was esteemed a prophylactic. What the dreaded evils were was suggested by Dr. Broca, who, whilst he believed that the operation was primarily conducted for therapeutic purposes, saw behind these the apprehension of a supernatural or demoniacal influence. Readers of Lenormant's "Chaldean Magic" will remember "the wicked demon which seizes the body, which disturbs the body," and that "the disease of the forehead proceeds from the infernal regions, it is come from the dwelling of the lord of the abyss." With such an antiquated record before us it is, therefore, by no means an extravagant theory to broach, as Dr. Broca has done, that many of the convulsions of childhood, which disappear in adult life, were regarded as the result of demoniacal possession. This being granted, what more natural than to assist the escape of the imprisoned spirit by boring a hole in the skull which formed his prison. When a patient survived the operation he became a living witness to the conquest of a fiend, and it is comprehensible that a fragment of his skull taken after death from the very aperture which had furnished the exit would constitute a powerful talisman. Chaldean demons, as we know, fled from representatives of their own hideous forms, and, if they were so sensitive on the score of personal appearance, others may have dreaded with equal keenness the tangible record of a previous defeat. It is certain that to cranial bones medicinal properties were ascribed, a belief in the efficacy of which persisted to the dawn of the eighteenth century; whilst, in recent years, such osseous relics were worn by aged Italians as charms against epilepsy and other nervous diseases. When once the dogma was promulgated that sanctity and a perforated skull were correlated, fond relatives might bore

the heads of the departed to facilitate the exodus of any malignant influence still lingering within, and to ensure them, by the venerated aperture, a satisfactory position in their new existence. For similar reasons the bone amulet was buried with the deceased, and sometimes it was even placed within his skull. Dr. Munro considers it hard to say for what purpose such an insertion should have been made, but, arguing from his data, the practice does not appear to me difficult of explanation. He has shown that disease was the work of a demon imprisoned in the skull; that this demon was expelled through the trepanned hole; and that its margins were thus sanctified for talismanic purposes. The unclean spirit was gone out of the man, and observation showed that, during the man's earthly existence, he did not return; but what guarantee was there that in the dim unknown region to which the deceased was passing the assaults of the evil one might not be renewed, that he might not return to his house whence he came out, and, with or without other spirits more wicked than himself, enter in and dwell in the swept and garnished abode? Surely, with such a possibility before them, it was the duty of pious mourners to offer all the protection that religion could suggest, and to defend the citadel with that potent amulet which recorded the previous discomforture of the besieger. The *post mortem* trepanning may have been such a pious endeavour to carry sacramental benefits beyond the grave, as induced the early Christians to be baptised for the dead, and, if there be truth in the deductions which have been made from the evidence, they point not only to a belief in the supernatural and in the existence of a future state, but also to that pathetic struggle of human love to penetrate the kingdom of death, which has persisted from the death of "Cain, the first male child, to him that did but yesterday suspire."

The possibility of reasonably making such deductions from a few decayed bones is a remarkable proof of the progress of anthropological science. Should any readers regard these deductions as unwarranted, they must remember that their value is dependent upon a series of facts which can here only be but very imperfectly reproduced. For these evidences in full sequence reference should be made to the paper by Dr. Munro, which forms the subject of this notice, and which will amply repay perusal.

FRANK REDE FOWKE.

ANIMAL HEAT AND PHYSIOLOGICAL CALORIMETRY.[1]

THE problem of animal heat is one of the oldest problems of scientific speculation. Nevertheless it is only within recent years that we have been able to speak of it in terms of modern knowledge.

Among the earliest contributors to such knowledge we may cite John Mayow and Joseph Black. Mayow was the first to suggest that atmospheric air is not a simple element and that its "nitro-aeric particles," in combining with the blood in the lungs, produce the animal heat, while Black demonstrated that the air expired by the lungs contains "fixed air" or, as we now call it, carbonic acid.

Priestley discovered oxygen gas in 1771, but Lavoisier was the first to show that this constituent of the air is taken in by the blood in the lungs, and that its combination with the carbon, which is a regular constituent of all organic matter, produces animal heat in the same way as in all combustions. Lavoisier was the first, too, who measured the heat produced by an animal, making use of the ice calorimeter, constructed by himself and Laplace, while Crawford nearly at the same time made investigations with an apparatus similar to our water calorimeter.

Neither form of apparatus is very suitable for this purpose. Scharling, Vogel, and Hirn made use of an air calorimeter. Within the last few years Prof. d'Arsonval of Paris adopted the same principle, and I myself have worked out the theory of it, and constructed apparatus, with which I have made a great number of experiments.

The animal to be experimented upon in my apparatus is placed in a chamber surrounded by double metallic walls. The heat given out by the animal raises the temperature of the air contained between the walls, until the radiation from the outer surface causes a loss of heat equal to the amount gained by it from the animal. This state of things having been established, the temperature of the air becomes constant, the gain and loss of heat being equal. In this way the heat given out can be calculated.[1]

The chamber containing the animal is well ventilated by aspiration. If we measure the volume of the air aspired and conduct a part of it through liquids absorbing carbonic acid, the amount of this gas given out by the animal can be measured. In another series of experiments the amount of oxygen absorbed by the animal was also measured. The combination of apparatus I made use of for this purpose is a variation of the method invented by Regnault and Reiset.

I shall not weary you with a long enumeration of all my experiments. All I wish is to give a brief account of some of the results, which I think are of interest from a general biological point of view.

In the first place, I may mention my experiments on fever. The high temperature in cases of febrile disease—is it the result of greater heat production? Are we to assume that certain poisons taken into the body, or produced in it by microbes, stimulate the nervous system, or directly influence the tissues in such a way as to cause greater oxidation, and thus to produce more heat?

That is the opinion of many medical men, but it is met with the great difficulty that neither the expiration of carbonic acid nor the excretion of oxidized nitrogenous matter is increased to such a degree as to account fully for the rise of temperature. Therefore Traube, the late clinician of Berlin, proposed the theory that the rise of temperature in fever is caused, not by greater heat production, but by greater retention of heat.

On producing fever in animals by injection of various putrid substances, I found that at the beginning of the fever, heat production is not increased, that the loss of heat is diminished, and that the difference between the normal loss and that observed in the period of rising temperature is sufficient to cause the febrile rise. When the temperature reaches its highest point the amount of heat given out rises and comes to its *normal* rate. Finally, when the fever begins to subside, during the period of falling temperature, the loss of heat is greatly increased.

All this is in perfect accordance with Traube's theory. Nevertheless, I cannot say that heat production is *never* augmented in fever. I have not yet been able to make many experiments on man. There are two great difficulties in the way, and the greatest is the impossibility of making a strict comparison between the heat production in fever and that in the normal state, except in cases of the regular intermittent type. Malaria, once so frequent in several parts of Germany, nowadays, thanks to hygienic improvements, is very seldom met with. So I have been able to make only two experiments on an individual afflicted with intermittent fever, some on invalids with abdominal typhus (typhoid fever), some on cases of pneumonia, and others on cases of fever caused by the injection of Koch's tuberculine during the short time when such injections were practised in the hospitals of Erlangen. In these cases I found a small but real augmentation of heat production, and therefore I am inclined to suppose that the question is not yet solved. Perhaps there are two causes able to raise the temperature in fever, one of them prevailing in some cases or types of fever.

Most of my studies were conducted with a view to explain the connection between heat production and other physiological functions, and the influence of external circumstances on it. Higher animals, mammals and birds, maintain their own temperature nearly at the same degree, even when the temperature of the surrounding air changes within large limits. Is this *regulation*, as we call it, caused by adaptation of heat production to the greater or smaller loss, or are there means to keep the loss constant in spite of the changing difference between the animal and surrounding objects?

On measuring the heat production of the same animal in cold and warm air, I found that it is smallest in air of medium temperature, *i.e.* about 15° C., becoming greater in lower and in higher temperatures. Thus an animal produces and loses nearly the same amount of heat in air at 5° as in air at 25°. In this case regulation of the animal temperature can be effected only by changes of the co-efficient of emission of heat from the skin, caused by changes of circulation. But for longer periods

[1] Paper by Prof. Rosenthal of Erlangen, read before the Biological Section at the Edinburgh meeting of the British Association for the Advancement of Science.

[1] For a fuller account see my papers in: *Archiv für Physiologie*, 1889, and in *Sitzungsber. d. K. preuss.* Akad. d. Wissensch. 1888-1892.

that regulation is insufficient. In winter time we use thicker clothing, we need more food, and if the cold is very great, we produce more heat by muscular action. In accordance with that experience, I found that animals produce more heat in winter than in summer. If nourished with the same food, sufficient to maintain their weight constant in winter, they do not oxidize the whole in summer, and therefore they gain in weight. It is remarkable that similar changes were observed by Dr. Karl Theodor, Duke of Bavaria, in the amount of carbonic acid expired by a cat, in the case of which he measured the expiration of this gas during five months.

Many experiments have been made to find the combustion heat of our food-stuffs. For want of direct animal calorimetry, physiologists used these data for calculating the heat produced by living beings; but as my experiments show, there is frequently no exact accordance between the two.

Richly nourished animals produce less, sparely nourished ones more, heat than the calculation gives. Between the two cases there is a third one in animals *sufficiently* nourished, viz. such as take in so much nutriment as serves to maintain their weight unchanged for a long time. In this case only the amount of heat produced is really equal to that calculated upon the combustion of the constituents of food. But also in this case variations are observed, caused by change of temperature, muscular motion or other circumstances, so that only the middle figures correspond exactly to the theoretical value.

Thus, if a well-nourished animal is starved the heat production remains unchanged from three to four days, the animal burning its stored-up materials and losing much of its weight; only then is it suddenly reduced to a lower amount. If now food is given again, heat production remains small, the weight increases, and then, three or four days later, the heat production increases and reaches its former amount.

If a sufficiently nourished animal takes in all its food once a day, the heat production varies very regularly in the twenty-four hours. Two hours after the meal it begins to rise, comes to its maximum point between the fifth and seventh hour, falls suddenly between the eleventh and twelfth hour. In the second half of the period the changes are small, the minimum point being usually in the twenty-third hour.

Similar changes go on in the expiration of carbonic acid. But after the meal it rises much more rapidly, and therefore comes earlier to its maximum point. Thus the ratio between heat production and expiration of carbonic acid is not a constant. This is true not only in the daily period. The variations are seen to be still greater when we compare different animals, or the same animal at different times and in different states of nutrition.

By such researches we are enabled to examine more exactly what chemical changes are going on in the animal system. The materials afforded by food are all oxidized at last, and leave the body in the form of carbonic acid and nitrogenous matter like urea. What in a longer period is burnt in such a way, we can, with a certain degree of exactness, make out by chemical examination of the constituents of food on the one hand, and of the excretions on the other. We can make up, in such a way, a balance account for gain and loss of the animal, like the balance account of a merchant. But such an account gives no exact knowledge, because we have no means of completing it by taking an inventory. We are, as regards the living body, in the same position as a political economist, who knows the amount of goods imported into and exported out of a country, but does not know what has become of the goods stored up or used up in the country itself. Therefore political economists do not now regard the mere balance of trade as being so important as they formerly thought.

Physiology, like all branches of science, begins with a mere description of processes observed. With the progress of our knowledge, reason tries to connect these processes one with another, and with those going on in lifeless nature. What we call *understanding* is nothing else than knowing such connections. Now in the case of bodily income and expenditure, it is easy to observe that all materials going out of the system are more oxidized than those taken in as food, and reason tells us that the combination of these food materials with the oxygen inspired must be the source of animal heat. Hence, we have no doubt that the amount of heat produced must correspond to the amount of chemical processes going on during the same time. But these processes we cannot observe directly; we can only observe the final products carbonic acids and others, when they leave the body. But by some of the processes heat may be produced or absorbed without any visible change of the body as a whole, viz. by solution of solid matter, by splitting highly complex substances into more simple ones, by forming sugar out of starch or glycogen out of sugar. Considering this, we need not wonder that for a long time it was impossible to answer the question whether there is any other source of heat production in animals besides oxidation. Only long continued calorimetric measurements have enabled me to fill up this gap.[1] This done, I thought it possible to discover also something about these inner processes, by comparing, hour for hour, the heat production with the excretion of carbonic acid, and with the absorption of oxygen.

If the ratio between the heat produced and the carbonic acid expired changes, this cannot be explained otherwise than by the fact that different chemical substances are burned. Each substance, according to its chemical constitution, gives out, when oxidized, a certain amount of carbonic acid, and produces a certain amount of heat. But in the system it is a mixture of different substances which come to be oxidized. This mixture changes, not only in animals differently nourished, but also in the same animal in different periods of digestion. After a rich meal, what comes into the circulation first must be that part of the food that is easily and rapidly digested and easily and rapidly absorbed. Such substances are the proteid matters. Later, the other constituents of the food, especially fat, come to the tissues, where they are burned. Now *fats*, for the same amount of carbonic acid, produce far more heat than proteids; so, during the first hours of digestion the afflux of oxidizable matter to the tissues being very great, both heat production and expiration of carbonic acid increase, but the latter in a far higher degree than the former.

The animal body may be compared, as Prof. Huxley so well says, to an eddy in a river, which may retain its shape for an indefinite length of time, though no one particle of the water remains in it for more than a brief period. But there is not only the difference between the animal eddy and the eddy of the river, viz. that the matter which flows into it has a different chemical composition from the matter which flows out of it, but in addition, matters which make up the eddy in a given time, change, if I may so say, their chemical value, combine with or separate from each other, without any visible change of the whole system.

The study of heat production is of the greatest value. No doubt, the study of the vital processes becomes more complicated when we take into account the invisible internal changes occurring in the body. But simplicity is not the highest aim in scientific inquiries; the highest possible exactness is that to which we must aspire. Happily, the history of science shows that after trying several ways to solve complex problems, we find that one of them leads to a higher point of view, whence things appear in all their completeness, simplicity and distinctness. Towards such a point of view my researches are but the first step. Let us hope that the united forces of many physiologists will shorten the time necessary for the completion of the work.

MAGNETIC PROPERTIES OF LIQUID OXYGEN.[2]

AFTER alluding to the generous aid which he had received both from the Royal Institution and from others in connection with his researches on the properties of liquid oxygen, and to the untiring assistance rendered him by his co-workers in the laboratory, Prof. Dewar said that on the occasion of the commemoration of the centenary of the birth of Michael Faraday he had demonstrated some of the properties of liquid oxygen. He hoped that evening to go several steps further, and to show liquid air, and to render visible some of its more extraordinary properties.

The apparatus employed consisted of the gas-engine down stairs, which was driving two compressors. The chamber containing the oxygen to be liquefied was surrounded by two circuits, one traversed by ethylene, the other by nitrous oxide. Some liquid ethylene was admitted to the chamber belonging to its circuit, and there evaporated. It was then returned to the

[1] See also my address delivered to the general meeting of the German Association of Naturalists at Bremen, 1890.

[2] Abstract of Friday evening discourse delivered at the Royal Institution by Prof. Dewar, F.R.S.

compressor as gas and liquefied, and thence, again, into the chamber as required. A similar cycle of operations was carried out with the nitrous oxide. There was a hundredweight of liquid ethylene prepared for the experiment. Ethylene was obtained from alcohol by the action of strong sulphuric acid. Its manufacture was exceedingly difficult, because dangerous, and as the efficiency of the process only amounted to 15 or 20 per cent. the preparation of a hundredweight of liquid was no light task. The cycle of operations, which, for want of time, was not fully explained, was the same as that commonly employed in refrigerating machinery working with ether or ammonia.

The lecturer then exhibited to the audience a pint of liquid oxygen, which by its cloudy appearance showed that it contained traces of impurity. The oxygen was filtered, and then appeared as a clear transparent liquid with a slightly blue tinge. The density of oxygen gas at − 182° C. is normal, and the latent heat of volatilisation of the liquid is about 80 units. The capillarity of liquid oxygen at its boiling-point was about one-sixth that of water. The temperature of liquid oxygen at atmospheric pressure, determined by the specific heat method, using platinum and silver, was − 180° C.

Reference was then made to a remarkable experimental corroboration of the correctness for exceedingly low temperatures of Lord Kelvin and Prof. Tait's thermo-electric diagram. If the lines of copper and platinum were prolonged in the direction of negative temperature, they would intersect at − 95° C. Similarly, the copper and palladium lines would cut one another at − 170° C. Now, if this diagram were correct, the E.M.F. of the thermo-electric junctions of these two pairs of metals should reverse at these points. A Cu − Pt junction connected to a reflecting galvanometer was then placed in oxygen vapour and cooled down. At − 100° C. the spot of light stopped and reversed. A Cu − Pd junction was afterwards placed in a tube containing liquid oxygen, and a similar reversal took place at about − 170° C.

Liquid oxygen is a non-conductor of electricity: a spark taken from an induction coil, one millimetre long in the liquid requires a potential equal to a striking distance in air of 25 millimetres. It gave a flash now and then, when a bubble of the oxygen vapour in the boiling liquid came between the terminals. Thus liquid oxygen is a high insulator. When the spark is taken from a Wimshurst machine the oxygen appears to allow the passage of a discharge to take place with much greater ease. The spectrum of the spark taken in the liquid is a continuous one, showing all the absorption bands.

As to its absorption spectrum, the lines A and B of the solar spectrum are due to oxygen, and they came out strongly when the liquid was interposed in the path of the rays from the electric lamp. Both the liquid and the highly compressed gas show a series of five absorption bands, situated respectively in the orange, yellow, green, and blue of the spectrum.

Experiments prove that gaseous and liquid oxygen have substantially the same absorption spectra. This is a very noteworthy conclusion considering that no compound of oxygen, so far as is known, gives the absorptions of oxygen. The persistency of the absorption through the stages of gaseous condensation towards complete liquidity implies a persistency of molecular constitution which we should hardly have expected. The absorptions of the class to which A and B belong must be those most easily assumed by the diatomic molecules (O_2) of ordinary oxygen; whereas the diffuse bands above referred to, seeing they have intensities proportional to the square of the density of the gas, must depend on a change produced by compression. This may be brought about in two ways, either by the formation of more complex molecules, or by the constraint to which the molecules are subjected during their encounters with one another.

When the evaporation of liquid oxygen is accelerated by the action of a high expansion pump and an open test-tube is inserted into it, the tube begins to fill up with liquid atmospheric air, produced at the ordinary barometric pressure.

Dr. Janssen had recently been making prolonged and careful experiments on Mont Blanc, and he found that these oxygen lines disappeared more and more from the solar spectrum as he reached higher altitudes. The lines at all elevations come out more strongly when the sun is low, because the rays then have to traverse greater thicknesses of the earth's atmosphere.

Michael Faraday's experiments made in 1849 on the action of magnetism on gases opened up a new field of investigation. The following table, in which + means "magnetic" and − means "negative," summarises the results of Faraday's experiments.

Magnetic Relations of Gases (Faraday).

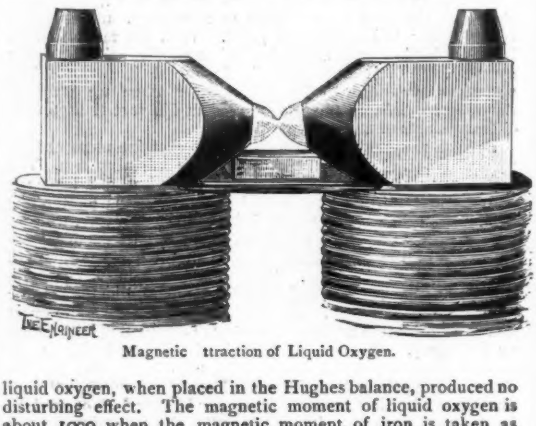
	In Air.	In Carbonic Acid.	In Hydrogen.	In Coal Gas.
Air	o	+	+ weak	+
Nitrogen	−	−	− strong	−
Oxygen	+	+	+ strong	+ strong
Carbonic acid ...		o	−	− weak
Carbonic oxide...	−	−	−	− weak
Nitric oxide ...	− weak	+	+	...
Ethylene ...	−	−	−	− weak
Ammonia ...	−	−	−	...
Hydrochloric acid	−	−	− weak	...

Becquerel was before Faraday in experimenting upon this subject. Becquerel allowed charcoal to absorb gases, and then examined the properties of such charcoal in the magnetic field. He thus discovered the magnetic properties of oxygen to be strong, even in relation to a solution of ferrous chloride, as set forth in the following table:—

Specific Magnetism, Equal Weights (Becquerel).

Iron	+	1,000,000
Oxygen...	+	377
Ferrous chloride solution, sp. gr. 1·4334	+	140
Air	+	88
Water	−	3

The lecturer took a cup made of rock salt, and put in it some liquid oxygen. The liquid did not wet rock salt, but remained in a spheroidal state. The cup and its contents were placed between and a little below the poles of an electro-magnet. Whenever the circuit was completed, the liquid oxygen rose from the cup and connected the two poles, as represented in the cut, which is copied from a photograph of the phenomenon. Then it boiled away, sometimes more on one pole than the other, and when the circuit was broken it fell off the pole in drops back into the cup. He also showed that the magnet would draw up liquid oxygen out of a tube. A test-tube containing



Magnetic ttraction of Liquid Oxygen.

liquid oxygen, when placed in the Hughes balance, produced no disturbing effect. The magnetic moment of liquid oxygen is about 1000 when the magnetic moment of iron is taken as 1,000,000. On cooling some bodies increased in magnetic power. Cotton wool, moistened with liquid oxygen, was strongly attracted by the magnet, and the liquid oxygen was actually sucked out of it on to the poles. A crystal of ferrous sulphate, similarly cooled, stuck to one of the poles.

The lecturer remarked that fluorine is so much like oxygen in its properties, that he ventured to predict that it will turn out to be a magnetic gas.

Nitrogen liquefies at a lower temperature than oxygen, and one would expect the oxygen to come down before the nitrogen when air is liquefied, as stated in some text-books, but unfortunately it is not true. They liquefy together. In evaporating, however, the nitrogen boils off before the oxygen. He poured two or three ounces of liquid air into a large test-tube, and a smouldering splinter of wood dipped into the mouth of the tube

was not re-ignited; the bulk of the nitrogen was nearly five minutes in boiling off, after which a smouldering splinter dipped into the mouth of the test-tube burst into flame.

Between the poles of the magnet all the liquefied air went to the poles; there was no separation of the oxygen and nitrogen. Liquid air has the same high insulating power as liquid oxygen. The phenomena presented by liquefied gases present an unlimited field for investigation. At $-200°$ C. the molecules of oxygen had only one-half of their ordinary velocity, and had lost three-fourths of their energy. At such low temperatures they seemed to be drawing near what might be called "the death of matter," so far as chemical action was concerned; liquid oxygen, for instance, had no action upon a piece of phosphorus and potassium or sodium dropped into it; and once he thought, and publicly stated, that at such temperatures all chemical action ceased. That statement required some qualification, because a photographic plate placed in liquid oxygen could be acted upon by radiant energy, and at a temperature of $-200°$ C. was still sensitive to light.

Prof. M'Kendrick had tried the effect of these low temperatures upon the spores of microbic organisms, by submitting in sealed glass tubes blood, milk, flesh, and such-like substances, for one hour to a temperature of $-182°$ C., and subsequently keeping them at blood heat for some days. The tubes on being opened were all putrid. Seeds also withstood the action of a similar amount of cold. He thought, therefore, that this experiment had proved the possibility of Lord Kelvin's suggestion, that life might have been brought to the newly-cooled earth upon a seed-bearing meteorite.

In concluding, the lecturer heartily thanked his two assistants, Mr. R. N. Lennox and Mr. J. W. Heath, for the arduous work they had had in preparing such elaborate demonstrations.

SCIENTIFIC SERIALS.

IN the *Journal of the Royal Agricultural Society of England* (third series, vol. iv. pt. 1) there is an interesting paper on the home produce, imports, consumption, and price of wheat over forty harvest years, 1852–3 to 1891–2, by Sir J. B. Lawes and Dr. J. H. Gilbert. This paper, extending to fifty-five pages, contains a general review of the produce of the experimental plots at Rothamsted, from which they have annually calculated the wheat crop of this country.—The first of the official reports is that of the Royal Veterinary College on investigations conducted for the Royal Agricultural Society during the year 1892. An interesting case of actinomycosis is related; a heifer with tongue badly diseased was put under Thomassen's treatment. Potassium iodide administered at first in doses of one drachm, twice daily, and the doses gradually increased to three drachms, effected a complete cure in about ten weeks.—Experiments have lately been made at the Veterinary College with Koch's tuberculin. The results in the case of seventy-two animals inoculated and afterwards killed show that "the tuberculin pointed out correctly the existence of tuberculosis in twenty-seven animals and wrongly in five, and it failed to indicate the existence of the disease in nineteen. In only three of the twenty-seven animals in which the tuberculin correctly pointed out the existence of tuberculosis could a positive diagnosis have been made by any other means." Experiments have also been made with Kalning's mallein, and "the results warrant the statement that mallein is an agent of greater precision than tuberculin, and that it is likely to render most important service in any attempt to stamp out glanders."

Wiedemann's Annalen der Physik und Chemie, No 4.—On electric discharges; the production of electric oscillations, and their relations to discharge tubes, by H. Ebert and E. Wiedemann. The influence of electric oscillations of given frequency in producing glow in vacuum tubes without electrodes was investigated by means of Lecher's wire system. The oscillations in the primary circuit were produced by means of an influence machine throughout. The terminals of the machine were connected to the primary condenser, consisting of four plates, to the further two of which the two Lecher wires, copper wires or thick metal tubes, were attached, running parallel for distances varying from 2 to 14 m., and ending in another condenser of variable capacity. The sensitive tubes were placed in various positions between or near the plates of the secondary condenser. It was found that wide tubes, not too short, glowed most readily. Nodes along the wires were discovered by means of wire bridges, which were moved along the wires until the tube glowed, or, if it was glowing already, until it reached a point where the glow became more intense and uniform. It was found that the position of the nodes was independent of the pressure in the tube, but that as evacuation proceeded the limits within which the tube would glow grew wider. Hence the most accurate method for finding the nodes, was by finding them for the highest possible pressure of gas in the tube.—On the comparison of intensities of light, by the photoelectric method, by J. Elster and H. Geitel. Apart from the dissipation of an electric charge from a negative zinc pole by ultra-violet radiation, it is also possible to measure the intensity of optically active light by an electric method. If a clean surface of potassium is joined to the negative pole of a battery, and a platinum or aluminium electrode to the positive pole, and the two electrodes are placed in a vacuum cell, the illumination of the potassium surface will allow a current to flow whose strength will be proportional to the intensity of the light source, and can be measured by means of a galvanometer. That this is really the case was proved by measuring independently in this way the intensities of two luminous sources, and then combining them, when the resultant reading was found to be equal to the sum of the other two, within the limits of constancy of the sources themselves. The greatest effect is produced by the blue rays.—Also papers by Messrs. Bjerknes, Zahn, Voigt, Richarz, Ambronn, Christiansen, Goldhammer, and Oberbeck.

Meteorologische Zeitschrift, March.—Iridescent clouds, by H. Mohn.—The paper contains observations made at Christiania during the years 1871–1892, together with a detailed investigation of the formulæ recently employed. During this period iridescent clouds were only visible on forty-two days; in some years the phenomenon failed entirely, and was not observed during the whole lustrum 1876–80. The great majority of cases occurred in December and January, but a few occurred in summer; the phenomenon was also seen somewhat more frequently at sunset than at sunrise or mid-day, but the difference is so small as to make it appear that its occurrence is independent of the time of day. The height of the clouds varied from about fourteen to more than eighty miles, the lower level being about twice the height at which ordinary cirrus clouds are usually seen at Christiania. The phenomenon appears to have some connection with the state of the weather, as an examination of the synoptic charts showed that it mostly occurred during the prevalence of stormy weather in the North Atlantic and over Northern Europe, and when the air was dry and warm at Christiania.—On the determination of wind force during gusts of a Bora storm, by E. Mazelle. From an investigation of the anemometer observations at Trieste for the ten years 1882–1891, the greatest hourly velocity recorded was seventy miles. But as hourly values give little idea of the violence of individual gusts, the author adapted an ingenious electrical arrangement to the anemometer, by which he could record the number of revolutions of the cups in each second. During a storm on January 16 last, the gusts during the space of a few seconds reached the velocity equivalent to 100 to 140 miles an hour. Presuming the instrument to have been a large-sized anemometer, this high velocity is not unlikely, as in a paper read before the Royal Meteorological Society on May 18, 1881, by R. H. Curtis, a velocity at the rate of 120 miles an hour at Aberdeen is quoted as recorded in gusts lasting two minutes, while shorter intervals, if they could be measured, would no doubt show higher velocities; and at Sydney a velocity of 153 miles an hour was recorded during one or two minutes. In all these cases the factor 3 has been used for the ratio of the movement of the cups to that of the wind, but this factor has been shown to give a velocity which is nearly 30 per cent. too high.

Bulletin de la Société des Naturalistes de Moscou, 1892.—(No. 1.) The chief papers are:—The development of the gemmulæ in *Ephydatia fluviatilis*, by W. Zykoff.—Catalogue of Kazan Lepidoptera, continued, by L. Kroulikovsky.—Analogy between the solution of a gas and of a salt in indifferent solutions of salts, by I. M. Syetchenoff. The author's law, which was found or carbon dioxide $\left(y = ae - \frac{k}{x}\right)$, holds good within certain limits, for the solution of salts in the same solutions; but the latter must only be taken either weak or of medium strength.—New plants and insects from Sarepta, by Alex. Becker.—On a

mesozoic fish from the Altai, by J. V. Rohon (*Lepidotus altaicus*, n. sp.).—On the cells of some conjugata devoid of nucleus, by J. Gerasimoff.—(No. 2.) The Rhinoceridæ of Russia, and the development of Rhinoceridæ, by Marie Pawloff. —Researches relating to some Protococcoidæ, by Al. Artari (in German). The work has been done chiefly in order to study the doubtful species. They were cultivated in different conditions, and proved to be independent species. At the same time the author experimented upon the influence of various media upon variations; the latter proved to occur within certain well-defined limits only, not exceeding the specific differences. The Algæ, when returned to their previous conditions, may return to their previous forms, thus proving a certain resistance of the organism against the medium. The following new species are described:—*Glæocystia nægeliana*, *Pleurococcus simplex*, *P. conglomeratus*, *P. regularis*, *P. Beyerinckii*, and *Chlamydomonas apiocystiformis* (three plates).—The birds of the Government of Moscow, by Th. Lorenz, with preface by Prof. Menzbier (first paper). Eighty-eight species are mentioned, with remarks upon their manners of life, based upon many years' observations.

Zapiski (*Memoirs*) *of the Novoros Sian* (*Odessa*) *Society of Naturalists*, vol. xvii. 2.—N. Andrussoff contributes, under the name of bio-geographical notes, a paper on pelagic diatoms, which contains a list of all named species of diatoms which have hitherto been found, either free, or in the stomachs of pelagic animals, both near to the coasts and in the open sea. The list is based on the researches of Hooker, Ehrenberg, Baddeley, Grunow, Castracane, and so on, down to the *Challenger* expedition, and the works of Murray, Hensen, and Brun, and it is followed by short remarks upon the geological importance of diatoms. The paper is summed up in German. —Prof. Sintsoff gives a list of Neogene fossils in Bessarabia, the following species being new:—*Acmæa* (*Scurria*) *Russi*, *tennissima*, *subrostata*, and *striato-costata*, *Acmæa pseudolævigata*, and *Buccinum subspinosum*.—D. Zabolotny discusses animal phosphorescence, and gives some facts on the same phenomenon observed in *limans*, near Odessa. The phosphorescent water was of a brown red colour, and contained masses of Daphniæ, Rotifers, and Infusoriæ. It appeared that luminosity was due to one Cilioflagellate, *Glenodinium*, from the *Peridinidæ* tribe, and it seems that light was emitted by the protoplasm itself of the little animal.—A. Lebedintseff describes the bathometer used in 1891 and 1892 during the explorations of the Black Sea; and G. Muskatblüth gives a note on mitotic division of leucocytes in circulating blood.

Annalen des K. K. Naturhistorischen Hofmuseums, viii. No. 1. (Wien, 1893.)—Dr. O. Finsch continues his "Ethnological experiences and authenticated objects from the South Sea." The present is the first paper on Micronesia, and deals with the Gilbert Islands. As is usual with Dr. Finsch's papers, it is well illustrated by eight plates, two of which are in colours, containing 110 figures, besides 16 wood-cuts. Although this paper, like the others of the series, is a catalogue of the objects collected by Dr. Finsch, and now in the National Museum in Vienna, it is at the same time an important contribution to the ethnography of Micronesia, a region of the great ocean about which comparatively little is known. The Gilbert Archipelago—often called the Kingsmill Islands—are best known to the frequenters of museums as the country of formidable weapons armed with serried rows of sharks' teeth, and of the coir armour which was worn as a defence against these deadly weapons. Dr. Finsch is of opinion that the Gilbert Archipelago, with Banaba and Nawodo, constitute a well-marked sub-province, as there is a distinct language, peculiar pantomimic dances (in which both sexes participate), characteristic tattooing, a special style of house, which latter are grouped into large villages, colossal assembly houses, well-built canoes, even for the South Sea, shark-tooth weapons, armour, a noose for catching eels, &c. He concludes by saying, "In every respect the Gilberts exhibit more affinity with Melanesia than with Polynesia, and least of all with Micronesia." The other articles are: "Characterless birds' eggs: an oological study" [on *Corvus corone*, *C. cornix* and *C. frugilegus*], by Emil C. F. Rzehak; "On the crystalline structure of meteoric iron," by G. Linck, and the usual official reports for 1892.

THE last three numbers received (2-4) of the *Bullettino della Società Botanica Italiana* contain a very large number of papers on the flora, phanerogamic and cryptogamic, of various districts of Italy and the adjacent countries, including an interesting note on the very rich flora of Monte Nerone. In addition to these Prof. R. F. Solla describes a case of polyembryony in the carob, *Ceratonia siliqua*, and also the structure of the tanniferous cells in the same plant. Sig. E. Baroni has a note on the relationship of calcicolous lichens to their substratum. Dr. C. Massalongo describes a gall on the bay, *Laurus nobilis*, due to the attacks of an insect which he regards as a new species, and names *Phytoptus Malpighianus*. Prof. G. Arcangeli gives the result of observations on the growth of the leaf-stalk of various species of Nymphæaceæ, which he finds to be greater in the case of immersed than of floating leaves. This he attributes to the vertical pressure of the water on the upper surface of the leaves in the former case. A paper by the late Prof. F. Pasquale was read, describing a fall of rain from lime-trees, quite unconnected with the manna produced by aphides, and due to the inability of transpiration to eliminate the whole of the water absorbed through the roots.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 23.—"Preliminary Notice on the Arrow-Poison of the WaNyika and other Tribes of East Equatorial Africa, with special reference to the Chemical Properties and Pharmacological Action of the Wood from which it is prepared." By Thomas R. Fraser, M.D., F.R.S., Professor of Materia Medica in the University of Edinburgh, and Joseph Tillie, M.D. (Edin.)

Burton,[1] Cameron,[2] and other travellers have given accounts of much interest of an arrow-poison used in warfare and in the chase by the WaNyika, WaKamba, WaGyriama, and other tribes of Eastern Equatorial Africa.

Several years ago, an opportunity was given to one of the authors to examine poisoned arrows, and the poison used in smearing them, of the WaNyika tribe. While the pharmacological action of this poison was found to have a close resemblance to that of *Strophanthus* seeds, its physical and chemical properties enabled the conclusions to be drawn that the poison was not made from these seeds, but was chiefly composed of an extract prepared from a wood.[3]

These conclusions have been confirmed by the examination of further specimens of the WaNyika arrow-poison, and of the wood from which it is prepared; and some of the results of this examination are stated in this paper.

The authors have separated from the arrow-poison and from the wood a crystalline glucoside, whose elementary composition, reactions and other characters they describe.

They have elaborately investigated the pharmacological action of this glucoside. The minimum-lethal dose for frogs was found to be about 0·00005 grain per 100 grains of weight of frog, and for rabbits about 0·000035 grain per pound of weight of animal.

The glucoside has a very pronounced action upon the heart. A large dose causes, in the frog, arrest of the contractions in a state of ventricular systole, and the heart soon afterwards acquires an acid reaction. After the heart is paralysed, respiration may continue for so long as an hour, and for a considerable time the frog can jump about actively. Smaller doses, on the other hand, slow the heart by prolonging diastole, and arrest its pulsations in a state of ventricular diastole. This diastolic arrest is not prevented by the administration of atropine, and is probably due to a direct action on the motor ganglia and muscle of the heart. The action on blood vessels is very slight. Transfusion experiments in the frog with a solution of 1 in 10,000 of saline produced only about the same effect as the pure saline solution alone.

A marked paralysing action is exerted upon the skeletal muscles, which also quickly pass into a condition of *rigor mortis*. The spinal cord and sensory and motor nerves are but little affected, and the former only doubtfully, except indirectly through the enfeebled circulation when large doses are administered. In warm-blooded animals, artificial respiration does not prevent death from cardiac failure.

In blood-pressure experiments, non-lethal doses were found to produce a remarkable slowing of the pulse, the vertical height of each pulse-curve indicating, at the same time, a great increase in the force of the ventricular contractions.

1 "The Lake Regions of Central Africa," 1860, vol. 2, p. 305.
2 "Across Africa", 1885, p. 59.
3 Fraser, "On *Strophanthus hispidus*: its Natural History, Chemistry, and Pharmacology," "Edinburgh Roy. Soc. Trans.," vol. 35, Part IV, 1890, pp. 966-67.

The action upon the circulatory, muscular and nervous systems, therefore, closely resembles of that strophanthin.

April 27.—"The Electric Organ of the Skate. Note on an Electric Centre in the Spinal Cord." By J. C. Ewart, M.D., Regius Professor of Natural History, University of Edinburgh. Communicated by Prof. Sir W. Turner, F.R.S.

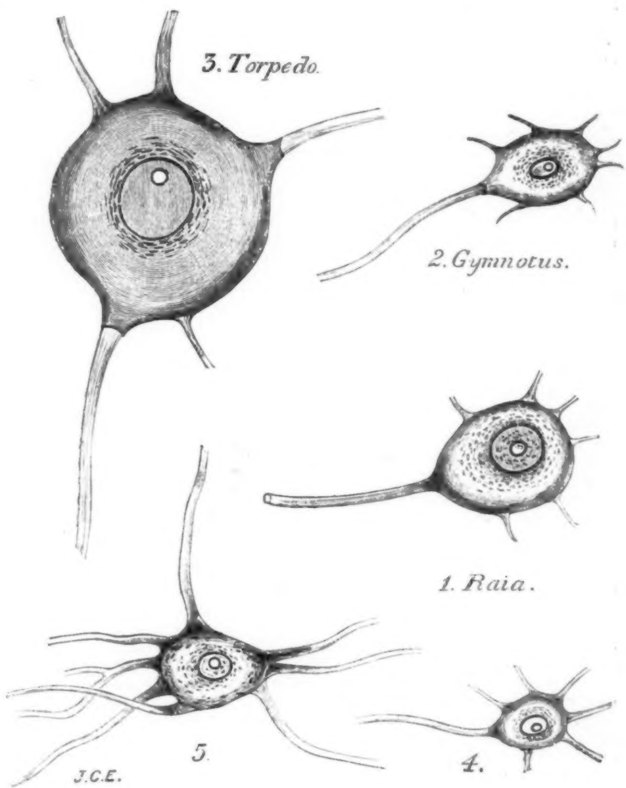
Having considered the development and structure of the electric organ of the Skate, it appeared to me desirable, by way of making my work more complete, to reinvestigate the nervous apparatus of the organ, and more especially to ascertain whether, as in *Torpedo* and *Gymnotus*, there is an electric centre. In *Torpedo* the electric organs are developed from a limited number of myotomes, and innervated by afferent fibres, belonging to a limited number of cranial nerves, which proceed from two large collections of cells—the electric lobes—situated in the region of the medulla. In *Gymnotus* the nerves for the electric organs proceed from two well-marked cellular tracts which extend along the greater length of the spinal cord, one at each side of the central canal. In the case of the Skate the question at the outset is, granting the existence of an electric centre, is it, as in *Torpedo*, situated in the brain or, as in *Gymnotus*, in the spinal cord? Sanderson and Gotch (*Journal of Physiology*, vol. x. No. 4), made out that in the Skate "a reflex centre is situated in the optic lobes," but, notwithstanding this, these lobes in the Skate in no way differ histologically from the corresponding structures in *Acanthias* and other Selachians unprovided with electrical organs.

The development of the Skate's organ from portions of the caudal myotomes, and its innervation by afferent fibres from certain caudal nerves, point to the electric centre being situated in the spinal cord rather than in the brain, and to its being, as in *Gymnotus*, on a level, and all but coextensive, with the electric organ.

Having observed, when working at the development of the electric organ, a number of large nerve-cells in the caudal portion of the spinal cord, the sections of Skate embryos made some years ago were first examined. It soon became evident that in sections from the middle of the tail on a level with the electric organ certain cells of the anterior horn of the cord were very much larger than in sections through the root of the tail, and further that in late embryos and very young Skate there was an electric centre, resembling in many respects the electric centre in *Gymnotus*.

It did not, of course, follow that the electric nerve-cells persisted into adult life. They might degenerate, and thus the supposed feebleness of the Skate's organ might be accounted for. The fact that the Skate's organ increases in size as the fish grows larger led me, however, to expect that large nerve-cells would be found in the caudal region of the spinal cord in well-grown fish. In this I was not disappointed, for, though there was at first some difficulty in demonstrating the presence of electric nerve-cells in large fish, on obtaining perfectly fresh material their position, size, and relations were easily made out, and the remarkable difference in the appearance of sections of the cord at, and in front of, the root of the tail, from sections on a level with the electric organ, was at once evident. From the observations already made, it appears that the electric centre in the Skate closely resembles, from a morphological point of view at least, the electric centre in *Gymnotus*. The electric tract is, however, much shorter in the Skate than in the Electric Eel, and the cells are relatively fewer in number. On the other hand, the cells in the Skate are larger than in *Gymnotus*, and this is true not only of *Raia batis* but also of *R. radiata*, in which the organ is extremely small and poorly developed. Nerve-cells from the electric centres of *Torpedo*, *Gymnotus*, and *Raia* are represented in the accompanying figures. Fig. 1 represents a cell from the electric centre of the Skate (a *R. batis* two feet in length); Fig. 2 a cell from the electric centre of a well-grown *Gymnotus*; and Fig. 3 a cell from the electric lobe of a large *Torpedo*. All three figures are camera drawings, and the same lenses were used in each case—objective D and ocular 2, Zeiss. It will be noted that, though the cell from the Skate is much smaller than the *Torpedo* cell, it is decidedly larger than the one from *Gymnotus*.

In sections of the Skate's cord on a level with the electric organ, small, as well as large, cells are usually visible in the anterior horn. The small cells are in connection with the fibres which supply the untransformed caudal muscles. They agree exactly with the cells in the anterior horn throughout the entire length of the spinal cord lying in front of the electric organ region. One of these unenlarged motor cells is represented in Fig. 4. It was drawn from a section of the cord (of the same fish from which Fig. 1 was taken), about six inches in front of the electric organ. It closely resembles, except in size, the electric cell (Fig. 1), and it also resembles the large motor cells of the Mammalian cord. A motor cell from the spinal cord of a Mammal, drawn to the same scale as the other cells given, is represented in Fig. 5.[1] This cell, smaller than the electric cell of the Skate (1), and still smaller than the cell from *Torpedo* (3), is about the same size as the electric cell of *Gymnotus* (2).



With the help of sections through a series of embryo Skate, for most of which I was indebted to Dr. Beard, I have been able to study the development of the cells in the Skate's electric centre. This part of the subject, together with the condition of the electric cells in large fish, will be dealt with in a subsequent communication. It may, however, be stated now: (1) That in *R. batis* embryos under 5 cm. in length none of the motor cells in the caudal region had undergone enlargement. (2) That in an embryo 5·8 cm. in length, although the muscular fibres seemed still unchanged, certain cells in the anterior horn of the caudal portion of the cord were distinctly larger than similarly-shaped cells in their vicinity. (3) That in an embryo 15·5 cm.

[1] For the use of the section from which Fig. 5 was drawn I am indebted to Sir William Turner, F.R.S.

in length, in which the electrical elements were already well developed, the electric nerve-cells were large and conspicuous, so that sections through the cord in the region of the electric organ presented quite a different appearance from sections through the root of the tail, where no change had taken place in the cells of the anterior horn.

May 4.—"On the Differential Covariants of Plane Curves, and the Operators employed in their Development." By R. F. Gwyther, M.A., Fielden Lecturer in Mathematics, Owens College, Manchester. Communicated by Prof. Horace Lamb, F.R.S.

"On the alleged Increase of Cancer." By George King, F.I.A., F.F.A., and Arthur Newsholme, M.D., M.R.C.P. Communicated by Dr. J. S. Bristowe, F.R.S.

The general result is that the supposed increase in cancer is only apparent, and is due to improvement in diagnosis and more careful certification of the causes of death.

Chemical Society, April 20th.—Dr. Armstrong, president, in the chair. The following papers were read:—A contribution to the chemistry and physiology of foliage leaves, by H. T. Brown and G. H. Morris. This paper deals with the occurrence, relations and physiological significance of the starch, diastase and sugars contained in foliage leaves. The first part relates to the starch and diastase of leaves, and the second treats of the sugars of the leaf. A bibliography of the subject is appended. The work originated in an attempt to discover the explanation of the conditioning effect of "dry-hopping;" viz., the addition of a small amount of dry hops to finished beer. This was ultimately traced to the presence in the hop strobiles of a small, but appreciable, quantity of diastase, sufficient to cause slow hydrolysis of the non-crystallisable products of starch-transformation left in the beer, and to reduce them to a condition in which they can be fermented by the yeast. The authors were then led to enquire into the first formation of starch in the chloroplasts of the foliage leaf, the mode of its dissolution and translocation in the plant and the nature of the metabolised products; the results obtained are antagonistic to the assumption made by Sachs, that all the products of assimilation at some time take the form of starch. Only a small portion of the assimilated material exists at any one time as starch. The fluctuations in the amount of starch in leaves under various conditions were also determined. Wortmann's recent denial that diastase plays any part in the dissolution and translocation of starch in leaves is incorrect; the authors prove that, instead of leaves containing little or no diastase every leaf examined by them contained sufficient diastase to transform far more starch than the leaf can have contained at any one time. The difference between the author's and Wortmann's results is chiefly due to the faulty method of examination employed by the latter. The products of the hydrolysis of starch by leaf-diastase are identical with those formed by malt-diastase, maltose having been directly separated from the leaves; leaf-diastase is not able to convert maltose into dextrose, but the leaf contains an enzyme capable of inverting cane-sugar. The amount of diastase present varies greatly in different plants, and within narrower limits even varies in the same plant at different times; it is very high in the case of the Leguminosæ. Any conditions which favour a decrease in the leaf-starch result in an increase of the leaf-diastase; thus a marked increase in diastatic activity is observed with leaves kept in darkness. Contrary to Wortmann's statement, leaf-diastase can attack the starch-granule under certain conditions; no evidence could however be obtained of the disappearance of starch in killed leaves under the influence of the contained diastase, and the authors are led to the conclusion that the *first stage* of dissolution of the starch-granule in the leaf is in some way or other bound up with the *life* of the cell. From experiments on the leaves of *Tropæolum* the authors draw the following conclusions:—Cane-sugar is the first sugar to be synthesised by the assimilatory processes. This sugar accumulates in the cell-sap of the leaf-parenchyma whilst assimilation is proceeding vigorously, and when the concentration exceeds a certain point starch commences to be elaborated by the chloroplasts at the expense of the cane-sugar. This starch forms a more stable reserve material than the cane-sugar, and is only drawn on when the latter more readily metabolised substance has been partially used up. Cane-sugar is translocated as dextrose and levulose and the starch as maltose. From the invert-sugar derived from the cane-sugar, the dextrose is more readily used up for the respiratory processes, and possibly also for the new tissue-building, than is the levulose; hence in a given time more levulose than dextrose must pass out of the leaf into the stem. The reading of this paper was followed by an interesting discussion in which the President, Mr. Thiselton Dyer, Dr. D. H. Scott, Prof. Green and Dr. Lauder Brunton took part.—The interaction of alkali cellulose and carbon disulphide: cellulose thiocarbonates, by C. F. Cross, E. J. Bevan and C. Beadle. The maximum number of hydroxyl groups in alkali cellulose appears to be four, expressing cellulose as $C_{12}H_{20}O_{10}$. By the interaction of alkali cellulose and carbon disulphide, cellulose thiocarbonates result; these products, when treated with water, swell enormously and regenerate cellulose. From a study of a large number of these thiocarbonates the authors are led to assign to them the formula $CS\begin{array}{l}\diagup OX\\ \diagdown SNa\end{array}$, where X is the cellulose residue, a radicle of variable dimensions. The thiocarbonates yield solutions of extraordinary viscosity.—Sulphocamphylic acid, by W. H. Perkin, jun. On heating Walters' sulphocamphylic acid, a monobasic acid, $C_9H_{14}O_2$ distils; on dissolving this in sulphuric acid sulphocamphylic acid seems to be regenerated. By oxidation with permanganate the latter yields a dibasic acid, $C_{18}H_{22}O_7$, which on reduction gives another dibasic acid, $C_{18}H_{24}O_6$. The substance of the composition $C_{18}H_{22}O_7$ yields, on hydrolysis, hydroxymetaxylenecarboxylic acid ($CO_2H : Me : Me : OH = 1 : 2 : 4 : 5$). A number of salts and derivatives of the above substances are described.—Magnesium diphenyl, by Lothar Meyer. In reference to a recent note by Hodgkinson (NATURE, this vol., p. 22) the author states that magnesium diphenyl has been recently prepared in his laboratory; it is a voluminous powder and is spontaneously inflammable. The formation of pyridine derivatives from unsaturated acids, by S. Ruhemann. Ethyl methyldicarboxyglutaconate yields methylmalonamide and ethyl amidoethylenedicarboxylate with aqueous ammonia; with phenylhydrazine it gives ethyl methylmalonate and the ammonium compound of the pyrazolon $PhN\begin{array}{l}\diagup CO.C.COOEt\\ \qquad\quad \|\\ \diagdown NH.CH\end{array}$. Ethyl methylglutaconate gives β-methyl-αα′-dihydroxypyridine with aqueous ammonia and β-picoline on reduction with zinc dust. Similar reactions hold in the cases of the higher homologues of these two substances. Chlorinated phenylhydrazines, Part II., by J. T. Hewitt. Orthochlorophenylhydrazine does not yield a urazole when heated with biuret; both the meta- and para-isomerides give urazoles and their hydrochlorides yield semicarbazides with potassium cyanate. A number of other compounds are described.—The oxidation of tartaric acid in presence of iron, by H. J. H. Fenton. On adding a small quantity of hydrogen peroxide to a solution of tartaric acid containing a trace of ferrous salt, a yellow colour is produced which changes to violet on adding alkali. The substance which gives the colour with ferric salts seems to be represented by the formula $C_2H_2O_3$; it is crystalline and behaves as a powerful reducing agent. The author is still engaged in its examination.—The inertness of quicklime, by V. H. Veley. The author is still making experiments on the velocity of reaction between lime in various states of hydration and sulphurous and carbonic anhydrides at different temperatures.—The products of the interaction of tin and nitric acid, by C. H. H. Walker. This investigation is a continuation of the work of Veley on the conditions of the interactions of metals and nitric acid. The whitish substance formed by the action of fairly concentrated nitric acid on tin seems to have the composition $Sn(NO_3)(OH)_3$.—Interactions of thiourea and some haloid derivatives of fatty acids, by A. E. Dixon. Thiourea reacts with dichloracetic acid, yielding thiohydantoic acid and ultimately thiohydantoïn in accordance with the following equation:—

$$2CSN_2H_4 + CHCl_2.COOH = NH : C\begin{array}{l}\diagup S—CH_2\\ \qquad\quad |\\ \diagdown NH.CO,\ HCl\end{array}$$
$$+ HCl + S + H_2O + CN.NH_2.$$

α-monochlor (or brom) propionic acid interacts similarly with thiourea, giving methylthiohydantoïn; on boiling this substance with hydrochloric acid it yields β-methyldioxythiazole

$$CO\begin{array}{l}\diagup NH.CO\\ \qquad\quad |\\ \diagdown S-CHMe\end{array}.$$

Mathematical Society, May 11.—Mr. A. B. Kempe, F.R.S., president, in the chair.—The following communications were made:—On the collapse of boiler flues, by A. E. H. Love. The problem consists in discovering the conditions of a collapse of a thin cylindrical shell under external pressure, when the ends are constrained to occupy fixed positions. Since all problems of collapse depend on the geometrical possibility of finite displacements accompanied by only infinitesimal strains, it appears at the outset that unless the shell can receive a displacement of pure bending without stretching of the middle surface collapse is impossible. The assumed condition of no terminal displacement is equivalent to closing the ends of the shell, and, since a closed surface cannot be bent without stretching, this condition apparently precludes the possibility of collapse. On the other hand it is well known that, if the external pressure exceeds a certain value, an infinitely long cylindrical shell of given small thickness and given diameter will collapse under the pressure. The critical pressure has been determined by Bryan and Basset, who find the same result. It is therefore to be expected that, if the cylinder is of sufficient length, the extensional displacement which must be superposed upon the displacement of pure bending in order to satisfy the end conditions will be practically unimportant, except in the neighbourhood of the ends. The problem is thus reduced to discovering the order of magnitude of the length of the shell in order that it may be treated as infinite when the thickness is small. For this purpose consider the case where the pressure is just equal to the critical pressure, and the displacement of pure bending in the infinite cylinder is consequently of the form

$$u = 0, \quad v = \tfrac{1}{2}A \cos 2\phi, \quad w = A \sin 2\phi,$$

where A is a small arbitrary constant. The displacement u is parallel to the generator, v is along the circular section, and w along the radius outwards. By means of displacements of this form the equations of equilibrium can be satisfied, but the boundary conditions at the ends cannot. Now take the case of an infinite cylinder with an end $x = 0$, at which v and w must vanish, and seek a displacement involving both flexure and extension of the middle surface to be superposed on the displacement given by the above form, such displacement to satisfy the equations of equilibrium and the boundary conditions:—(1) that the new v and w are equal and opposite to those above given at $x = 0$; (2) that the new u, v, w vanish at $x = \infty$. The required solution can be determined and is of the form

$$u = e^{-mx}(A_1 \cos mx + B_1 \sin mx) \sin 2\phi,$$
$$v = e^{-mx}(A_2 \cos mx + B_2 \sin mx) \cos 2\phi,$$
$$w = e^{-mx}\frac{m^2 d^2}{4(2+\sigma)}(B_2 \cos mx - A_2 \sin mx) \sin 2\phi,$$

in which B_2 and A_2 can be determined so as to satisfy the conditions at $x = 0$, σ is the Poisson's ratio of the material of the shell, and

$$m = [12(1-\sigma^2)]^{\frac{1}{4}}/\sqrt{(dt)},$$

t is the thickness and d the diameter of the shell. If σ be taken equal to $\frac{1}{4}$ the reciprocal of m is about ·546 of the mean proportional between the thickness and the diameter, and it follows that whenever x is great compared with this quantity the influence of the end is unimportant, and the displacement approximates to one of pure bending. To make the tendency to collapse occur in practice, it would be necessary that the half length of the flue be great compared with m^{-1}, and the practical conclusion would be that for a flue of length l stability would be secured if

$$\tfrac{1}{2}l < n/m, \text{ or } l < N\sqrt{(dt)},$$

where N is a considerable number. It is customary in stationary boilers to make the flues in detached pieces connected by massive flanged joints, so that the effective length of the flue is the distance between consecutive joints. If the number N be taken equal to 12 we have the rule that the distance between the joints must be not greater than twelve times the mean proportional between the thickness and the diameter. The value $N = 12$ accords well with what has been found safe in practice, but the rule as to spacing the joints is new.—On some formulæ of Codazzi and Weingarten in relation to the application of surfaces to each other, by Prof. Cayley, F.R.S.—On the expansion of some infinite products, by Prof. L. J. Rogers.—On a theorem for bicircular quartics and for cyclides corresponding to Ivory's theorem for conics and conicoids, by Mr. A. L. Dixon. Using a form of the equation to these curves and surfaces (in quadricircular and pentaspherical co-ordinates) already studied by Darboux and Casey, the writer deduced that the ratio of the distance of any two points to the product of the lengths of the tangents from them to a fixed focal circle or sphere is the same as for the pair of corresponding points. He also showed how the theorem for the Cartesian oval could be derived from its equation in terms of elliptic functions.—A supplementary note on complex primes formed with the fifth roots of unity, by Prof. Lloyd Tanner. The author investigates a method of determining whether a complex number is prime or composite. The process takes two distinct forms, one of which was established, on different grounds, by Tchébicheff. The other appears to be new, and is convenient in testing the sets of complex integers described in the author's previous communication on the subject. The discussion is based upon a certain classification of complex integers according to the "orders" of their complexity, and this conception facilitates the direct factorization of complex numbers. The theory is restricted to the case of 5, but seems to be quite general.—On the linear transformations between two quadrics, by Mr. H. Faber. In *Crelle's Journal*, vol. v. (also Phil. Trans., 1858), Cayley gave a representation of the automorphic linear transformation of the unipartite quadric function in the notation of the theory of matrices. In the present paper the author extends Cayley's method to the determination of the general linear transformation of a given quadric into another given quadric, and applies the results to the determination of the general real linear transformation between two equivalent quadrics and to the reduction of a quadric to a sum of squares. The determination by this method of the general linear transformation between two quadrics depends upon the solution of an algebraic equation of the n^{th} degree, to which the problem as it originally presents itself—viz., the solution of a system of n^2 quadratic equations in n^2 variables, is thus reducible.—On maps and the problem of four colours, by Prince C. de Polignac.—On Fermat's proof of the problem that primes of the form $4n + 1$ can be expressed as the sum of two squares, by Mr. S. Roberts, F.R.S.

Entomological Society, May 10, Mr. Henry John Elwes, President in the chair.—Mr. R. McLachlan, F.R.S., exhibited for Dr. Fritz-Müller, of Blumenau, Santa Catarina, Brazil, specimens of larvæ and pupæ of a dipterous insect, and read a letter from Dr. Fritz-Müller on the subject. The writer stated that the larvæ were similar to those exhibited by Mr. Gahan, at a meeting of the society in October, 1890, and which were then thought by Lord Walsingham, F.R.S., and Mr. McLachlan, to be allied to the Myriapoda.—Mr. S. G. C. Russell exhibited specimens of *Hesperia alveolus*, including one of the variety *Taras*, taken by him at Woking in April last.—Mr. J. M. Adye exhibited a long series of *Moma orion*, *Eurymene dolobraria*, *Amphidasis betularia*, *Cloephora prasinana*, and a few specimens of *Notodonta dodonea*, *N. chaonia*, and *N. trepida*, *Acronycta alni*, and *Selenia illustraria*, all bred by him in March and April last, from larvæ obtained in the autumn of 1892 in the New Forest.—Mr. H. Goss read a copy of a letter received by the Marquis of Ripon, at the Colonial Office, from the Governor of the Gold Coast, reporting the occurrence of vast swarms of locusts at Aburi and Accra, West Africa, about the middle of February last. The writer stated that at Accra the swarm extended from east to west as far as the eye could see, and appeared to occupy a space about two miles wide and from a quarter of a mile to a mile in height.—Colonel Swinhoe stated that some years ago he had been requested by the Indian Government to report on plagues of locusts. He said he had witnessed swarms of these insects far larger than the one just reported from the Gold Coast, and mentioned that many years ago, when going up the Red Sea in one of the old P. and O. paddle boats, the boat had frequently to stop to clear her paddle-wheels from locusts, which had settled in such swarms as to choke the wheels and stop their action.—Mr. E. C. Reed, of Valparaiso, Chili, communicated a paper entitled "Notes on *Acridium paranense*, the migratory locust of the Argentine Republic." Colonel Swinhoe, Mr. Champion, Mr. Elwes, Mr. McLachlan, and Mr. Merrifield took part in the discussion which ensued.—Prof. L. C. Miall, F.R.S., communicated a paper entitled "Dicranota; a Carnivorous Tipulid Larva."—Dr. T. A. Chapman communicated a paper entitled "On a Lepidopterous pupa (*Micropteryx purpurella*) with functionally active mandibles." Mr. McLachlan said he thought Dr. Chapman's observations were of great value, and

tended to show that the position of *Micropteryx* was nearer the Trichoptera than had been supposed.—The President announced that the new Library Catalogue, which had been edited by Mr. Champion, with the assistance of Mr. McLachlan and Dr. Sharp, F.R.S., was now ready.

PARIS.

Academy of Sciences, May 15.—M. Lœwy in the chair.—On the quantitative determination of boron, by M. Henri Moissan. The determination is based upon Gooch's methyl alcohol method, in which several improvements were introduced. The boron is first obtained in the state of boracic acid by treating with nitric acid in a sealed tube. The boracic acid is separated by means of pure methyl alcohol. The reaction takes place in a bulb tube provided with a funnel which reaches down into the bulb and can be closed by a cock. Four distillations with alcohol are carried out, the vapours passing through a coil of glass tubing into a Bohemian glass flask. Any uncondensed vapour is absorbed by ammonia solution. The liquid collected is poured upon a known weight of pure slaked lime, forming calcium borate. The latter is calcined and weighed, and the increase of weight gives the amount of boric anhydride absorbed. To test whether the boron has all distilled over, a drop of the distilling liquid is caught on a strip of paper and placed in a flame, when a green colour will indicate any trace of boron. The slaked lime is kept, when not in use, in the form of a stable basic nitrate, which is made ready for use by a strong calcination. The quantity of lime should be 16 to 20 times the probable quantity of boracic acid. The process, though still somewhat laborious, has given very consistent results.—The working of the soil and nitrification, by M. P. P. Dehérain.—Re-appearance of certain latent affections (etiology and pathogeny), by M. P. Verneuil.—Results obtained with mixtures of butters and diverse fatty materials by means of the new method for the recognition of adulteration of butter, by M. Auguste Houzeau.—On the terms of the second order resulting from the combination of aberration and refraction, by M. Folie.—On the observation of the total eclipse of the sun of 16th April, made at Fundium (Senegal), by M. H. Deslandres.—The solar eclipse of 16th April, 1893, at the Vatican observatory, by P. F. Denza.—On a class of systems of ordinary differential equations, by M. Vessiot.—On the generalisation of the analytical functions, by M. G. Scheffers.—On the cases of integrability of the motion of a point in a plane, by M. Elliott.—On the general law and the formulæ of the flow of saturated water vapour, by M. H. Parenty.—On the dimensions of absolute temperature, by M. H. Abraham.—On a new kind of manometer, by M. Villard.—On the inversion of Peltier's phenomenon between two electrolytes beyond the neutral point, by M. Henri Bagard.—Study of the cadmium and sal-ammoniac cell, by M. A. Ditte.—Influence of the temperature of tempering upon the mechanical properties and the structure of brass, by M. G. Charpy.—On malic acid substitutions, by M. Ph. A. Guye.—Action of chloride of zinc upon chlorocamphor, by M. A. Etard.—On a certain number of organo-metallic combinations belonging to the aromatic series, by M. G. Perrier.—Inulasis and indirect alcoholic fermentation of inuline, by M. Em. Bourquelot.—Chemical phenomena of assimilation of carbonic acid by chlorophyll-bearing plants, by M. A. Bach.—On the meteoric iron of Augustinowka (Russia), by M. Stanislas Meunier.—Influence of the medium on respiration in the frog, by M. A. Dissard.—Action of oxygen and compressed air upon warm-blooded animals, by M. G. Phillippon.—On the ophthalmic nerves of *Spondylus Gæderopus*, by M. Joannes Chatin.—On the parthogenetic fragmentation of the ovules of mammifers during atresia of the Graafian follicles, by M. L. F. Henneguy.

AMSTERDAM.

Royal Academy of Sciences, April 28.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Kamerlingh Onnes exhibited isogonic charts for 1540, 1580, 1610, 1640, 1665, and 1680, drawn by Dr. van Bemmelen according to observations discovered by him in old, especially Dutch books, in the manuscripts of van Swinden and in old Dutch ship-journals.—Mr. Franchimont treated of hydrocyanic acid in plants. A short time ago Mr. van Romburgh found hydrocyanic acid, probably as an unstable compound with acetone (and perhaps with glycose), in the caoutchouc-yielding plants *Manihot glaziovii*, Müll. Arg., *Hevea brasiliensis*, Müll. Arg., and *Hevea spruceana*. Now Mr. van Romburgh has examined Indigofera's, and found that the leaves of the *Indigofera galegoides* D.C. (*Tarvem octan*), which do not produce indigo, and have no particular smell, yield a considerable quantity of hydrocyanic acid and of benzaldehyde by being weakened in water for two hours. By new researches Mr. van Romburgh will try to find out if this Indigofera contains amygdaline or laurocerasine, and whether the enzyme, to which the decomposition is due, is identical or not with emulsine. This seems to be the first time that hydrocyanic acid has been found in a plant belonging to the family of the Papilionaceæ.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Catalogue of the Library of the Entomological Society of London, edited by G. C. Champion (London).—Evolution and Religion: A. J. Dadson (Sonnenschein).—Zoology of the Invertebrata: A. E. Shipley (Black).—Archæological Survey of Egypt; Beni Hasan. Part 1: P. E. Newberry (K. Paul).—Some Further Recollections of a Happy Life (Macmillan).—Helps to the Study of the Bible (Oxford University Press).—A History of Crustacea: Rev. T. R. R. Stebbing (K. Paul).

PAMPHLETS.—Manchester Museum, Owens College Museum Handbooks, Outline Classification of the Animal Kingdom, 2nd edition (Manchester, Cornish).—Outline Classification of the Vegetable Kingdom (Manchester, Cornish).—Catalogue of the Type Fossils: H. Bolton (Manchester, Cornish).—The Romanes Lecture. 1893—Evolution and Ethics: T. H. Huxley (Macmillan).—Syllabus of Elementary Course of Botany: J. B. Philip (Aberdeen, Bisset).

SERIALS.—Dictionary of Political Economy, Part 5 (Macmillan).—Astronomy and Astro-Physics, May (Northfield).—Journal of the College of Science, Imperial University, Japan, vol. 6, Part 1 (Tōkyō).—American Journal of Mathematics, vol. xv. No. 2 (Baltimore).—Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie, Siebzehnter Band. 1. u. 2 Heft (Williams and Norgate).

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